

The Submerged Prehistory of Europe: A Methodological Approach to  
Underwater Site Discovery with Special Reference to the Mesolithic and  
Neolithic of the Eastern Adriatic

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for Martha & Lloyd



## Preface

This dissertation is written in (US) American English. Citations are produced within the text in parenthetical format: (author's surname & year of publication), specific page numbers listed only for direct quotation, as standard within APA (*American Psychological Association*) style of citation for social sciences. In line with APA regulations, format, spacing, punctuation and citation have been slightly modified from APA guidelines at the discretion of the author to meet the regulations of the University of Edinburgh. Citations which list more than two authors are referenced in text: (surname of the first author, *et al.*, year of publication). Figures and tables are referenced according to original publication or acknowledgement of photographer. All satellite images (except figure 5.3 © NASA) are © Google Earth.

Following traditional archaeological convention, dates in this dissertation are listed mainly as years BC, but also appear in BP, or c.BP. BC refers to calendar years which predate the Gregorian calendar (also commonly written 'cal BC'), BP refers to calibrated calendar years before present (also commonly written 'cal. BP'), and c.BP (eg. c.8000 BP) refers to uncalibrated radiocarbon years (also commonly written 'bp.' or 'uncal. BP'). Radiocarbon dates that have been printed with  $\pm$ /sigma (eg. 6700 $\pm$ 130 bp) have been calibrated to years BC; a calibration table is included in the appendix.

All supplemental documentation from the original survey of the Slovenian Adriatic is found in the appendix.

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## **Abstract**

The history, theory, methods and practice of underwater archaeology, and its application to prehistoric European archaeology are discussed herein. An emphasis is placed on coastal Mesolithic and Neolithic evidence to exemplify the impact of sea level rise on late Stone Age populations, and subsequently on European archaeology. The submerged archaeological sites and material discussed demonstrate the regional and historical background as well as the conditions of preservation and underwater field methodology. The broad themes of submerged site discovery, underwater archaeological methodology, and underwater evidence from Europe during the early Holocene are examined and applied to the eastern Adriatic region. A feasibility study, a pioneering survey of the Slovenian territorial sea, was conducted using a survey strategy developed in southern Scandinavia. Following the discussion of methodology and research design the results of the survey, which include historical, Classical, and prehistoric archaeological material are described. Finally, an application of underwater survey methods and submerged site presupposition are discussed in reference to theoretical future study of the eastern Adriatic coastal zone.

I hereby declare this work to be my own.

Jonathan Benjamin

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## Introduction

This doctoral dissertation examines the potential of underwater archaeological methodology to contribute to the record of occupation, migration and cultural activity of pre-Neolithic and Neolithic populations in submerged areas throughout Europe. A regional focus is placed on Slovenia and the eastern Adriatic where an underwater survey was conducted in the summer of 2005 with the aim of submerged site discovery. The late Mesolithic, and early Neolithic of this region are not well documented and in the best-preserved sites, located mainly in karstic caves, Neolithic ceramics appear as a 'middle Neolithic' or Vlaška culture which began during the late 5th Millennium BC (Boschian & Montagnari-Kokelj 2000). The enigmatic state of the archaeological record, and a notable lack of late Mesolithic and early Neolithic sites in the region, have prompted the question: "Where are the late [Mesolithic] hunters and gatherers?" (Biagi 2003, 150). Furthermore, the uncertainties relating to theories of migration versus diffusion, an important part of a greater European-wide debate concerning the Neolithization process, are relevant to Slovenia and the northeast Adriatic, and described herein. The impact of physical changes in the landscape and coastline of the northeast Adriatic region would have been significant and it is widely accepted that sea level rise throughout the early Holocene would have inundated coastal and plain sites in the region (Barfield 1972; Marocco 1989; Boschian 1993; Budja 1996; Biagi 2003; Forenbaher & Miracle 2005). Finally marine resources and human occupation and exploitation of coastal zones must be considered an important element of the Mesolithic and the ensuing Neolithization process:

*"The food sources of the ocean played a decisive role in the economy of foraging societies in the coastal zones everywhere in the world. No serious estimates on [transitional hunter-gatherer] population size and distribution can be obtained without knowledge of the coastal habitation. Furthermore it seems that the coastal sites contain by far the best potential for demonstrating Pre-Neolithic societies in their full scale of technological and social complexity."* (Fischer 1995, 435)

Since archaeological material from the Mesolithic and early Neolithic is sparse in coastal zones along the northeast Adriatic, it is suspected that undiscovered coastal

sites may further define the late Mesolithic and provide much needed information. Where are the late Mesolithic and early Neolithic inhabitants and why are few to no coastal sites represented in the archaeological record? The assumption is that any such sites would have been inundated by the rising Adriatic Sea, though no concerted effort has been undertaken to address these matters in the northeast Adriatic. Two questions are examined: 1) Do Mesolithic and Neolithic sites of the eastern Adriatic coastal region now exist underwater? 2) Can underwater archaeological methodology, similar to efforts conducted in southern Scandinavia, be a productive means for investigating the coastal zones and thereby contribute to discussions of demographics, population and cultural expansion, and dietary and social aspects of the Mesolithic and Neolithic in the eastern Adriatic region?

Studies conducted over the past several decades have indicated that global sea level rise during the period following the last glacial maximum, approximately 18,000 years ago, has impacted the earth's surface and dramatically changed coastal environments. Between 18,000 and 5,000 years ago, global seas continued to rise (Fairbanks *et al.* 1989). Melting glaciers, eustatic activity, isostatic land rebound and tectonic activity have significantly impact coastal as well as some inland landmasses throughout Europe (Flemming 1983; Lambeck *et al.* 1998, 2004). The impact on human groups during the late Pleistocene and early Holocene must not be underestimated, as the environment continued to change until temperatures and sea levels reached a relatively stable point approximately 5,000 years ago.

The specifics of climate change and sea level rise are found throughout this dissertation, with a description of global eustasy (Chapter 1), the impact of climate change on southern Scandinavia (Chapter 2) and the reconstructed paleolandscapes of the northeast Adriatic which are critically analyzed (Chapter 5). Evidence of coastal occupations, food processing sites and human and cultural migrations in European prehistory has been obtained through underwater archaeological methodology. The dynamics of environmental change and the resulting submergence of cultural landscapes are critical to underwater archaeological survey. Understanding paleolandscapes and potential locations of submerged cultural



activity requires a multi-disciplinary approach, which includes geological, biological, and archaeological studies the physical environment on both global and local scales (Pirazzoli 1996).

Though underwater archaeology has been conducted since the middle of the 20<sup>th</sup> century, it has been associated mainly with maritime or nautical interests, and tends to be Classical or historic in age (Bass 1966, 1972; Muckelroy 1978, 1980; Delgado 1997). Developments over the past three decades have shown a limited, albeit significant, emphasis on underwater methodology within the study of Stone Age sites (Chapter 1; Raban 1983; S.H. Andersen 1987, 1987; Flemming 1983, 2004; Fischer 1993, 1995; Galili et al. 1993, 1997; Schlichtherle 1997). While these publications are mainly from European sources, Stone Age underwater sites have been discovered and excavated outside of Europe, particularly in North America (e.g. Cockrell 1980; McLean 2001). It is the submerged European prehistory that is the focus of this dissertation, and sites outside of Europe are discussed only briefly for their methodological contributions. Furthermore, despite their great contribution to prehistoric archaeology, wetland sites (e.g. Coles & Coles 1996) lie outside the main focus of this dissertation. Submerged prehistoric bogs, generally in the form of peat horizons, found and excavated through underwater archaeological methods (Larsson 1983, Momber 2000), are discussed due to their location underwater.

Submerged Mesolithic and Neolithic sites are not well documented outside southern Scandinavia, due in part to the nature of the sites, but also to the existing bias within the prehistoric archaeological community. According to Bailey (2004, 3) as prehistoric archaeologists, “we are part of a much larger community which in general is far from convinced of the virtues of investigating submerged prehistoric archaeology, inclined to regard it as the playground of diving enthusiasts or an extremely costly enterprise with very uncertain rewards.” Bailey states that there are four common preconceptions and criticisms by the prehistoric archaeological community with respect to the value of underwater archaeological methodology applied to prehistoric sites: 1) Underwater remains have not been preserved, are too difficult or too costly to retrieve. 2) Finds from underwater sites are unlikely to

provide information that could not be more easily obtained on land. 3) Coastal settlement and marine paleo-economies are marginal to the main patterns of world prehistory. 4) The search for underwater civilizations advocated by amateur enthusiasts is a further symptom of a marginal field of study (Bailey 2004).

The importance of the coast to Stone Age hunter-gatherer populations has recently been addressed by prehistorians (Rowley-Conwy 1983; van Andel 1989; Larsson 1995; Bailey 2004). Advantages of coastal living<sup>1</sup> are simplified as follows: 1) Transportation and communication of people and culture. This encompasses trade and social activities, and includes travel by sea through migrations of populations and material culture. 2) Access to food resources, specifically the high availability and variety of marine and terrestrial plants and animals. 3) Access to other (non-food) resources. This includes fresh water in high water-table environments and at coastal river-mouths, as well as available material for tool production. Examples of these materials include pebbles and river rocks, driftwood, and other organic materials used for structures, tools and fuel.

Chapter 1 of this dissertation: *Underwater Archaeology and Applications in European Prehistory: History, Theory, Methods and Practice* provides context and demonstrates the field methodology concerning archaeology underwater and its application to prehistoric Europe. Furthermore, Stone Age sites from around Northern and Mediterranean Europe are described to illustrate the types of archaeological material discovered and the research questions such methodology aims to address. An emphasis is placed on coastal archaeology, impacted by sea level rise during the late Pleistocene and early Holocene, though selected inland lake sites are discussed in terms of their methodological relevance and historical contributions to the field of underwater archaeology. These case studies provide examples of the history and methodology, which can be applied to both regional studies of the eastern Adriatic, and future studies throughout Europe.

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<sup>1</sup> This simplification is based on Bailey (2004) who has listed eight reasons of coastal advantages for hunter-gatherers in prehistory.



Underwater archaeological methodology from southern Scandinavia has been refined over the past three decades, and survey methods for submerged site discovery are suggested to be applicable to other coastal locations (Fischer 1993). More prehistoric sites have been discovered and excavated from submarine environments in southern Scandinavia than anywhere else in the world. The archaeologists in southern Scandinavia have set the standard for underwater methodology and its application to Stone Age archaeology, and material from such sites has been used to address a variety of research questions within the greater fields of prehistory including subsistence (Pedersen 1995, 1997), trade (Klassen 2000) and social stratification through prestige goods (Fischer 2002), Mesolithic dwellings (Grøn 2003), settlement patterns (Schilling *et al.* 1997) and marine transportation (S.H. Andersen 1987). Thus, the second chapter of this dissertation is devoted entirely to *The Mesolithic and the Neolithization of Southern Scandinavia and the Contributions of Underwater Archaeology*. In addition to the discovery methodology and research questions relating to underwater archaeology in southern Scandinavia, the fieldwork model for the presupposition of coastal fishery sites is described. This model was the methodological foundation that was adapted for the 2005 survey of the Slovenian Adriatic Sea.

The background information and archaeological debates concerning the Mesolithic and Neolithization of Slovenia and the eastern Adriatic are described to provide regional context in Chapter 3: *Holocene Transitions in Western Slovenia & the Eastern Adriatic*. Based on the very limited knowledge of the coastal zone during the Mesolithic and Neolithic periods in the northeastern Adriatic a need for underwater archaeological survey is established. Furthermore, archaeological debates surrounding the Neolithization process in the eastern Adriatic, are discussed herein. The distribution of sites, and lack of coastal evidence described in this chapter have lead to the suggestion that underwater archaeology is necessary to realize the potential of the archaeological record in the region. A lack of material and conclusive evidence of the late Mesolithic and early Neolithic suggest that evidence of population expansion, diet, and social characteristics of the late Mesolithic and early Neolithic may exist underwater.

The limited underwater archaeological research historically conducted in the northeastern Adriatic Sea has focused mainly on historic, or Classical archaeology and is the subject of Chapter 4: *Underwater Archaeology of the Northeastern Adriatic*. This discusses previous fieldwork conducted in the region, and the types of material one could expect to discover during underwater survey. Furthermore, this summary will be used to demonstrate future opportunities for underwater methodology in the eastern Adriatic.

A pioneering survey of the Slovenian Adriatic Sea was conducted in the summer of 2005. Preparations, methodology, and the results of this pilot study are described in Chapter 5: *Original Fieldwork: An Underwater Archaeological Survey of the Slovenian Adriatic Sea*. A re-evaluation of regional and localized sea level data and reconstructed coastal landscapes is included at the end of this chapter.

Finally, following the experience and results of the 2005 survey, future studies and proposed underwater archaeological survey strategy for the eastern Adriatic are presented in Chapter 6: *A Reevaluation of the Applied Survey Model and a Proposed Future Strategy for Underwater Archaeological Site Discovery in the Eastern Adriatic*. Based on prior research, and the experience of the author's own fieldwork in the region, an assessment of the eastern Adriatic and locations of potential interest for underwater survey are described and explained. A modified version of the Danish model for site presupposition is introduced.

Price (1991, 231) states: "*We have little evidence from most areas about the coastal aspects of [Mesolithic] adaptations. It is critical to remember that the rising sea levels of the Holocene have submerged the early post glacial coastlines of much of the globe... The sooner archaeologists begin to look for such societies, the better we will come to understand the forager groups of the past.*"

This doctoral dissertation addresses the need for submerged site discovery, and establishes a practical methodology for future study, specifically designed for the eastern Adriatic region.

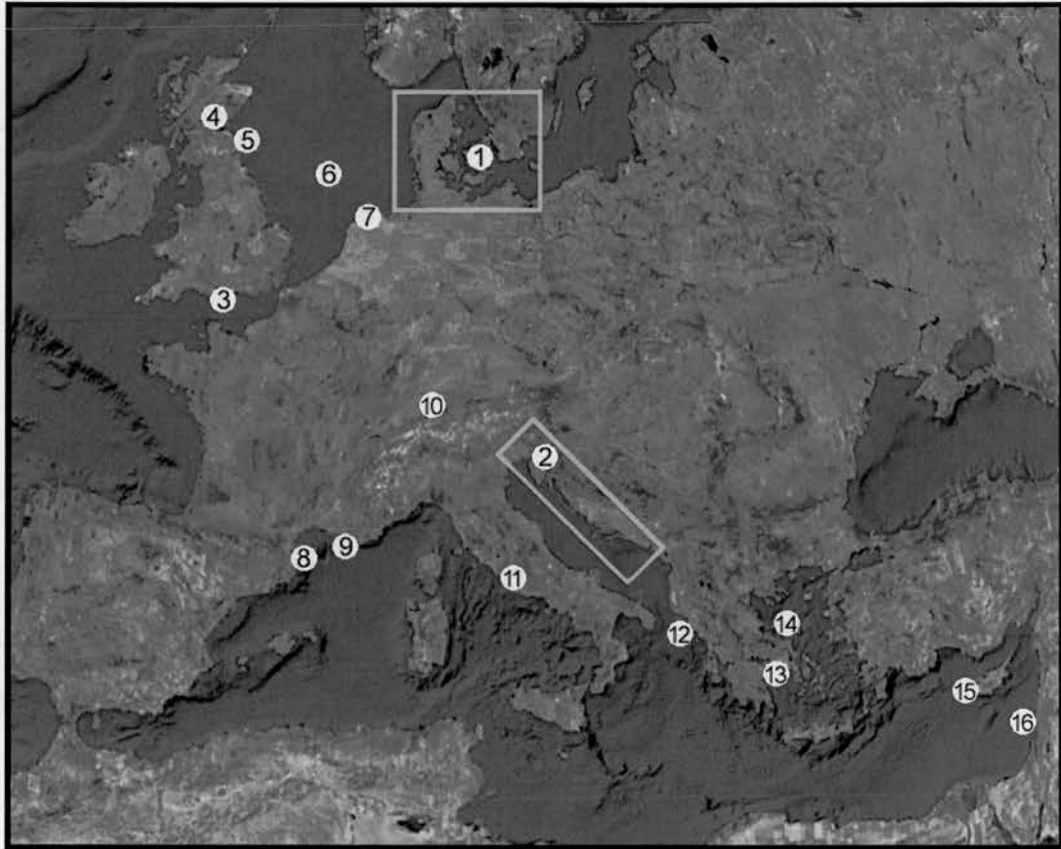


Figure 1 Sites and locations referenced in text.

1) Southern Scandinavia [fig 2 & chapter 2], 2) Slovenia and the eastern Adriatic [fig. 1 & chapters 3-6], 3) The Isle of Wight 4) Loch Tay, Perthshire 5) Brown's Bay, Tynemouth 6) 'Doggerland' 7) Dutch sites of the North Sea 8) Leucate 9) Cosquer Cave 10) Lake Zurich / 'Central European Alpine Lake sites' 11) La Marmotta 12) Corfu 13) Franchthi Cave 14) Aghios Petros 15) Western Cyprus: Aspros 16) Israeli Carmel coast

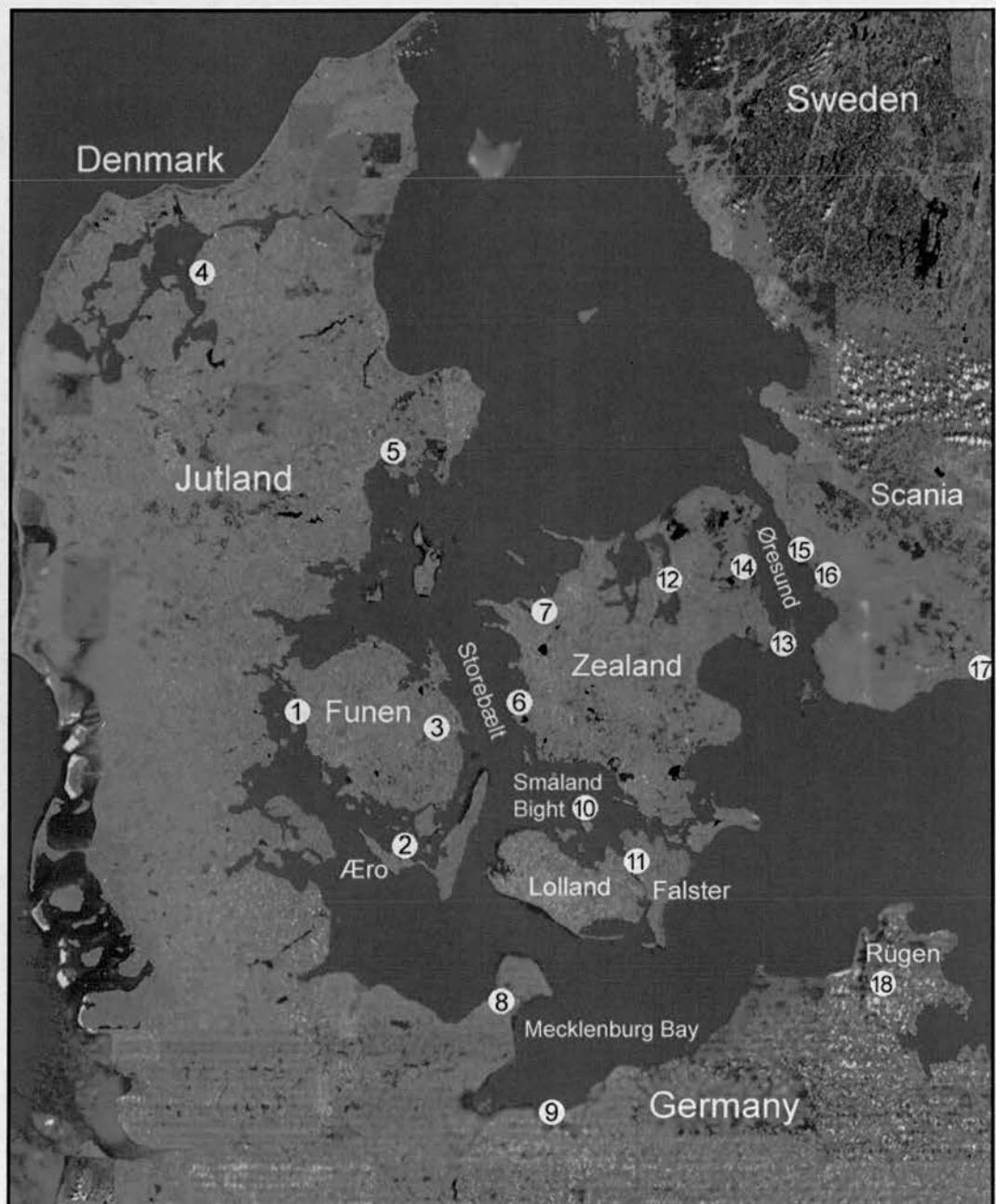


Figure 2 Southern Scandinavia: Selected sites and locations referenced in text.

- 1) Tybrind Vig 2) Mollegabet I & II 3) Lindholm I 4) Bjornsholm & Ertebølle 5) Kalo Vig  
 6) Musholm Bay, Korsør Nor, Margrethe Næs, Oleslyst, Halsskov 7) Nekselø &  
 Smakerup Huse 8) Wangels 9) Wismar Bay: Timmendorf-Nodrmole 10) Småland Bight:  
 Vigsø Skål, Malmgruden, Femø Skollerev 11) Argus Bank 12) Blak II 13) Svalerumpen  
 14) Vedbæk 15) Pilhagen 16) Tågerup 17) Skateholm 18) Rugen



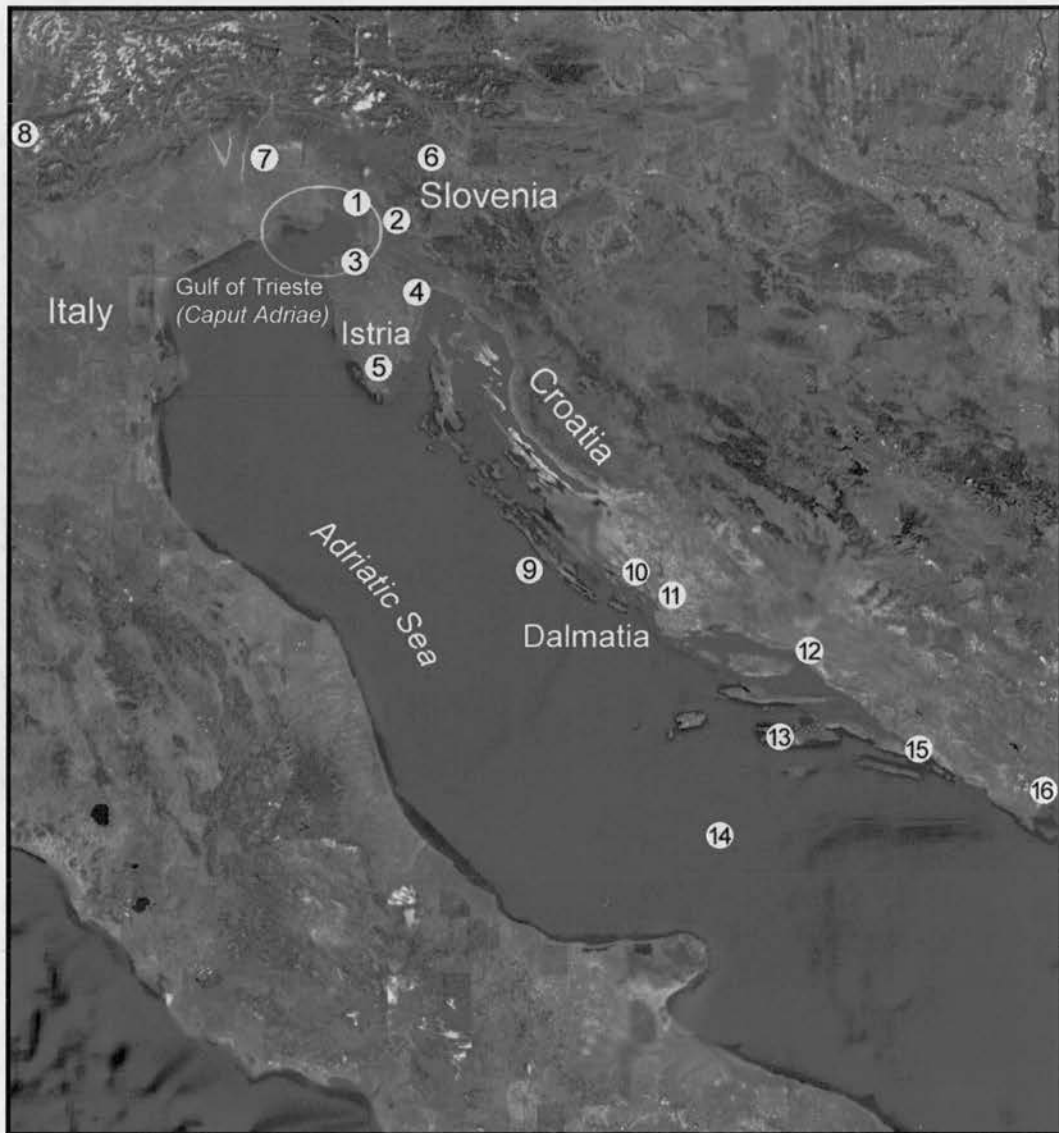


Figure 3 The Eastern Adriatic Region: Selected sites and locations referenced in text.

1) Cave sites of the Triestine karst: Grotte dell'Edera, Grotta Azzura, Grotta Benussi 2) Slovenian karst: Mala Triglavca & Viktorjev Spodmol 3) Slovenian Adriatic sites: Sermin, Fazine, Punta Piran 4) Pupičina Peč 5) Vižula 6) Ljubljana Moor: Breg, Zalog pri Verdu. 7) Friuli Plain: Sammardenchia 8) Adige Valley 9) Dugi Otok 10) Stipanec 11) Danilo 12) Baška Voda 13) Korčula: Vela Spila 14) Palagruža 15) Gudjna Pečina 16) Gulf of Kotor: Spila Iznad Perasta (Spila Pečina)

## **Chapter 1**

### **Underwater Archaeology & Applications in European Prehistory: History, Theory, Methods and Practice**

## Introduction

The history, theory, methods and practice of underwater archaeology, and its application to prehistoric European archaeology are discussed herein. Additionally, an emphasis is placed on coastal Mesolithic and Neolithic evidence to exemplify the impact of sea level change on Stone Age populations, and subsequently on European archaeology. The processes of submergence of underwater archaeological sites are described, and the terms, 'underwater', 'maritime' and 'nautical' archaeology are defined. Numerous texts have been devoted to the broader topic of archaeology underwater (Bass 1966; St. John Wilkes 1971; Muckelroy 1978, 1980; Gianfrotta *et al.* 1981; Green 1990; Dean *et al.* 1992; Blot 1996; Volpe 1999; Ruppé & Barstad 2002), thus, this chapter serves to discuss current theory and methodology rather than to duplicate previous efforts. Furthermore, the submerged archaeological sites and material described demonstrate the regional and historical background as well as the conditions of preservation and underwater field methodology. The resulting synthesis provides a context for the broader themes of this dissertation: submerged site discovery, underwater archaeological methodology, and the underwater evidence from northern Europe and the Mediterranean region during the late Stone Age.

### 1.1 Terminology: 'Underwater', 'Maritime' and 'Nautical' Archaeology

While it is tempting to consider underwater archaeology as a subject within archaeology, all types of underwater methodology should not be confused for a single discipline. Variations in scope and practice abound within archaeology underwater and the terminology used to define the sub-fields can be confusing since 'Underwater Archaeology' is often used synonymously with 'Maritime Archaeology' or 'Nautical Archaeology'.<sup>2</sup> There exists a preconceived notion about underwater archaeology both within popular culture as well as the archaeological community; "To most people maritime archaeology means wrecks, spectacular time

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<sup>2</sup> One example is the main English language publication concerned with archaeology underwater: *The International Journal of Nautical Archaeology* is devoted to all types of underwater archaeology, and is not limited to 'nautical archaeology' as defined by Muckelroy.



capsules like the Mary Rose. Less appreciated are the extensive prehistoric landscapes...” (Miles 2004, xiii). Delgado has defined ‘Underwater archaeology’ as the practice of archaeology regardless of site type or age, which occurs in a submerged environment and ‘maritime archaeology’ as “the archaeological study of maritime culture through sites such as shipwrecks, buried ships, and harbours.” (Delgado 1997, 7). ‘Nautical archaeology’, as defined by Muckelroy (1978), is the archaeology pertaining to boats and ships,<sup>3</sup> which is mainly but not always conducted by underwater research. Additionally, ‘Maritime archaeology’ is that which is related to all aspects of maritime affairs, including technology and other aspects of seafaring. Maritime archaeology may be conducted through both underwater and traditional land archaeology asserts Muckelroy: “In the case of archaeology under water, it is those sites which are not concerned directly with maritime activities, notably submerged ancient land surfaces” (Muckelroy 1978, 9). Thus the term which Muckelroy proposed for non-ship, nor maritime related archaeology conducted underwater is simply “archaeology under water.”

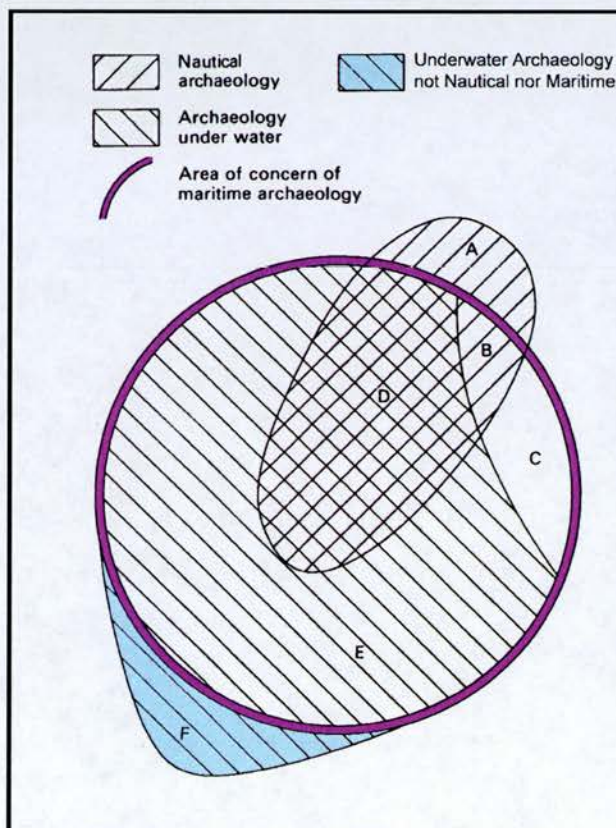


Figure 1.1 Fields of archaeology concerned with underwater methodology (after Muckelroy 1978). Nautical Archaeology and Maritime Archaeology are not always underwater as illustrated by areas B & C. Submerged sites, which can be historic or prehistoric, and are not found within the scope of Nautical or Maritime Archaeology are indicated by area F.

<sup>3</sup> ‘Shipwreck Archaeology’ has been described as its own classification (Gould 1983).



In addition to the stated terminology, archaeology underwater has been historically described as “Aqualung Archaeology” and “Sea Digging” (Borhegyi 1958; Casson 1953).<sup>4</sup> Since the focus of this dissertation is on prehistoric sites, the term ‘underwater archaeology’ is applied. Nevertheless, nautical and maritime archaeology often directly relate to prehistoric underwater archaeology from a historical, practical and methodological perspective. Furthermore, because finds from all time periods may be discovered during underwater fieldwork, familiarity with maritime theory can play an important role, especially during survey. Additionally, many of the tools, methods and principles of survey and excavation from maritime or nautical archaeology may be either directly applied or adapted to suit submerged prehistoric sites.

## **1.2 An Introduction to Underwater Archaeology: History & Methodology**

Recent overviews on the history and timelines of underwater archaeology have established a chronology of underwater technology and artifact recovery throughout history (e.g. Blot 1996; Broadwater 2002).<sup>5</sup> ‘Breath-hold’ underwater salvage diving was recorded by Herodotus as early as 480 BC, and the use of the Open Bell diving system is said to have existed in Greece as early as 350 BC (Broadwater 2002). As early as the Byzantine empire, a version of *Lex Rhodia* existed whereby laws of salvage entitle divers to keep a percentage of any goods they retrieved from shipwrecks (Blot 1996). A more detailed, and perhaps the first solid account of the Open Bell diving system is known to have been used from the 16<sup>th</sup> century (Goggin 1960; Broadwater 2002) and is associated with early efforts in Italy. Italian Architect Leon Battista Alberti began searching for Roman Barges in lake Nemi in 1446, his successor Francesco Demarchi (1504-76), is noted as having dived with an ‘instrument’ in 1536 (Blot 1996).

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<sup>4</sup> See references in Goggin (1960)

<sup>5</sup> See timetable listed by Broadwater (2002, p. 18) and sources therein.

Underwater archaeology has long been connected to advances in diving technology, which has allowed the science to evolve from early days of salvage (Broadwater 2002). The Siebe diving apparatus, with the simple and effective copper close diving helmet fed by a pump from the surface, was first developed in 1819. In 1839 the copper helmet was connected to a water tight suit which remained the status quo in diving technology for a century. During this period of innovation in the 19<sup>th</sup> century, the Deane brothers began investigating the Mary Rose, while Ferdinand Keller began to advance ideas on the lake dwellings of Lake Zürich in Switzerland (Blot 1996; Broadwater 2002). By the late 19<sup>th</sup> century, divers from the Austro-Hungarian empire were called upon to investigate submerged sites in central Europe (Gaspari 2003). In 1936, the *aqualung* was introduced as the first stand-alone diving unit, and along with the new technologies of the glass face mask and “rubber foot fins” changed practical diving and archaeology underwater forever (Goggin 1960, 348). Following the development of the self-contained underwater breathing apparatus (SCUBA), the popularity of sport diving has much encouraged the technological progress of diving equipment. This has continued to advance underwater researchers’ ability to safely and effectively investigate submerged environments.

As early as the 1950’s there was need to define ‘underwater archaeology’ within the archaeological community.<sup>6</sup> Goggin (1960, 350) defined underwater archaeology as “the recovery and interpretation of human remains and cultural material of the past from underwater by *archaeologists*.” Thus, the early practice of underwater artifact recovery cannot be considered archaeology by modern standards and should instead be classified as ‘underwater salvage’. The topic of archaeology versus salvage has been more recently addressed and clearly defines salvage practices as outside the parameters of underwater archaeology (Dean *et al.* 1992). While salvage is defined as simply artifact recovery and removal, underwater archaeological practice is subjected to the methodological requirements and documentation of material culture and context, given the realistic limitations of working conditions.

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<sup>6</sup> Goggin’s *Underwater Archaeology: Its nature and limitations* was printed in *American Antiquity* in 1960, however it was written in May of 1959 and summarizes known research during the 1950’s.

In modern underwater archaeology, SCUBA diving and the ability to breathe and thus work underwater is taken for granted. There are however numerous considerations which must be acknowledged when working underwater: "It is almost impossible to describe to someone who has never dived what it is like to work underwater; for various technical reasons, even the most realistic of underwater films give a partially false impression. Much of the peculiarity of the experience can be traced to the fact that the diver is effectively weightless under water..." (Muckelroy 1978, 24). Coupled with gravity, pressure and mobility issues, limited visibility and communication make underwater archaeology physically different from archaeology on land. In addition to the reality of working underwater, there are numerous basic principles of dive theory which must be considered. Since a comprehensive overview of dive theory and diver safety is outside the scope of this dissertation, the methodology herein mainly concerns general practices in underwater research and excavation of archaeological sites.<sup>7</sup> Nevertheless, practical dive theory must be applied in the field and is a fixed consideration in any underwater archaeological project that includes SCUBA diving.

Underwater archaeological methodology has been discussed in practical terms for over half a century. Goggin (1960) describes the early practice in the 1950's, and according to Blot (1996) the first underwater archaeological conference took place in Cannes, France in 1955. In the following decade, additional comprehensive scientific texts were published on the subject (e.g. Bass 1966) and in 1971, St. John Wilkes published *Nautical Archaeology, A Handbook*. In spite of its focus on 'nautical archaeology', this work illustrates numerous logistical and practical methods for survey and excavation in an underwater environment. Many of the methods presented by St. John Wilkes are applicable to the search for submerged prehistoric sites and remain relevant nearly four decades later. Muckelroy (1978) contributed to the discussion on practical underwater survey and excavation, building on the works of Bass and St. John Wilkes, and consolidating the known

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<sup>7</sup> Numerous international and local diving organizations have published literature on general diver safety and theories around diving; the two largest international sport diving organizations are PADI and CMAS.

submerged archaeological sites throughout the world (Muckelroy 1980). Recently, Green (1990) and Babits & Van Tilburg (1998) published practical texts both called *Maritime Archaeology*, while Dean *et al.* (1992) have produced *Archaeology Underwater: The NAS Guide to Principles and Practice*. Additionally, Flemming & Max (1990) have edited a comprehensive and practical approach in *Scientific Diving: A general code of practice*. Although not specifically archaeological, this publication describes a variety of logistical topics including organization, equipment and legal matters of a scientific diving operation.

### **Underwater archaeological survey**

The success of an underwater survey can depend largely on the underwater surveyor, and “the need for training is indisputable. Practically anyone can don mask, aqualung, and fins and swim underwater ... but this is not enough” (St. John Wilkes 1971, 11). This refers primarily to safety considerations, and readiness to manage individuals in potentially dangerous situations. However, this same necessity for training exists in terms of the archaeological element of underwater research. A diver must be trained to look for specific, sometimes less obvious objects, particularly, when searching for prehistoric material. It has been suggested that it is much easier to teach an archaeologist how to dive, than a diver to become an archaeologist (Goggin 1960). Thus, training is imperative for underwater surveyors and excavators since ancient material preserved in a submerged environment can be fragile and is easily damaged. This is particularly true of organic remains, valued finds in underwater sites due to their potential preservation. As an example, wood can be well preserved, though water-logged wood poses its own difficulties when handling, hence a properly trained staff is essential (Muckelroy 1980; Robinson 1998).<sup>8</sup> Muckelroy states that there is a strong need for competence underwater; “the diver himself is the biggest problem underwater; his ability to perform effectively, and to make reliable observations, can be severely restricted. These limitations need not be totally debilitating, but they impose certain constraints on the scope and

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<sup>8</sup> See chapter 8 on ‘Conservation’ in Muckelroy (1980).



potential of any work under water.” (Muckelroy 1978, 36). In conclusion, there is an immense amount of skill required of both the archaeological *and* the diving techniques, which are required for proper underwater field archaeology.

In addition to the consideration of diving staff, St. John Wilkes has stressed the importance of preparation and project planning. “Study of charts will have told much about the bottom, about the tides, and currents in the area... and of course, the depth, which will play an important part in determining the method of search.” (St. John Wilkes 1971, 95). Once on location, a survey method or different techniques may need to be tested. Swim-line techniques require multiple divers or snorkelers to maintain a constant distance which will vary depending on the visibility of the water, the material of the seabed and its depth. St. John Wilkes suggests beginning in deeper water moving toward land. This allows for reference points on land, and for tired swimmers to finish surveying in shallow waters, near shore (Green 1990; Chapter 3, fig. 3.10). This is consistent with standard diving practice which suggests beginning dives in deep waters and ending in shallows to allow for decompression and overall health.

Swimming close to the surface is not productive for a sweep search in which obstacles are present. It is best to swim as high above the bottom as possible while still able to see the bottom clearly (St. John Wilkes 1971). During ‘close cover survey’, however, divers may need to be closer to the seabed. This is especially true if the seabed composition is cluttered with material such as rubbish, sea-life, or irregular topography. It may also be required when the sought archaeological indicators may be small, such as flint or ceramic material. St. John Wilkes has diagramed surveys pattern for broad scale survey including single and double jackstay systems whereby the divers follow a linear pattern along a rope (St. John Wilkes 1971, 101) and close cover survey techniques, where divers are required to investigate the ground closely (p. 110).<sup>9</sup> Nevertheless, even when proper survey is conducted using visual observations, test excavation may be required in order to

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<sup>9</sup> A discussion of survey methodology and equipment will be included in chapter five of this dissertation.

discover archaeological material and define the area of a submerged site (e.g. Flemming 1983b).

### **Site definition and excavation underwater**

After the discovery of a submerged site, a number of techniques may be applied to refine the area of archaeological interest. Underwater archaeological excavation techniques vary depending on the site type and the methods deemed appropriate for excavating archaeological material and surrounding matrix. Prior to engaging in a comprehensive excavation, a site should ideally be spatially defined in order to establish an excavation plan. Locating and pinpointing the site has been traditionally conducted using a variety of visual survey and measurement techniques such as photographic transits, compass bearings, distance and bearing by sextant (St. John Wilkes 1971; Dean *et al.* 1992). Developments in mapping technologies, particularly through satellite global positioning systems (GPS) have changed the way sites are defined, and mapped (Chapter 5, fig. 5.15; Gaspari 2005, 2006). Additionally, taking depths with floats, staffs and plane tables can still be useful (Dean *et al.* 2002, figs. 88, 90) although some of these practices have been replaced by echo-sounding devices, computerized depth gauges and laser measurements from shore in the case of shallow sites (fig. 1.5).

The use of industrial dredges or mechanical digging machines have been applied, during non-archaeological excavations by industry, and have lead to discovery of submerged prehistoric sites in Europe (Geddes *et al.* 1983; Coles 1998; Flemming 2004). Although generally too coarse for archaeological purposes, they can be appropriately employed, especially in the initial stages of site discovery or during rescue excavations (Fischer 2004). Coring the seabed matrix where cultural material has been discovered is one method of excavation to test for further material beneath the surface (St. John Wilkes 1971, figure on p.16), though the potential for destruction of archaeological material must be acknowledged. Additionally, this can be a productive method for geological and environmental sampling, and perhaps dating the subsurface strata (e.g. Gifford 1983, Momber 2000), and can be applied

either vertically, or horizontally, depending on the nature of the matrix. Test pits, or trenches may also be conducted during initial excavation (e.g. Flemming 1983). While underwater archaeological methodology has evolved over the past decades, the need for scientific methods, proper documentation, and careful handling of material remains.

There is no single method for underwater archaeological excavation. Galili describes excavating a submerged Neolithic village as a situation in which “the marine archaeologist must deal with the same problems in land excavation (stratigraphy, duration of site occupation, function of features), but with the additional complications presented by the sea and limitations of diving.” (Galili *et al.* 1993, 135). Variables which affect methodology include the depth and size of a site, seabed composition/matrix, accessibility and elements such as currents, visibility and weather. Experimentation at the submerged Mesolithic site at Tybrind Vig took place over a ten year period (Malm 1995), during which numerous practical methods were tested. At Oakbank crannog in Perthshire, Scotland, countless approaches in excavation technique have been tested over the past two and a half decades (Dixon 2004). Additionally, new technology (e.g. GPS and laser EDM’s)<sup>10</sup>, and progress in diving technology will continue to advance underwater archaeological fieldwork both in terms of accessibility, as well as accuracy. Since every site poses different challenges based on the stated variables, it is the task of the underwater archaeologist to safely and scientifically contend with the obstacles at a submerged site.

Underwater excavation may be carried out manually, with hand tools similar to those used in land excavation including trowels, brushes, bags and buckets. Additionally, three methods for the removal of material which have been commonly used in underwater archaeology are the airlift, the water pump, and the dredge (St. John Wilkes 1971). The air lift, in use since the 1950’s (Blot 1996), employs compressed air pumped to a hose or pipe which creates a suction and is used for removing material to the surface where it can be sorted or disposed. Rather than vacuum up

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<sup>10</sup> See [www.leica-geosystems.com](http://www.leica-geosystems.com) for geosystems and EDM’s, and [www.garmin.com/marine](http://www.garmin.com/marine) for examples of consumer grade marine related GPS and sonar systems.

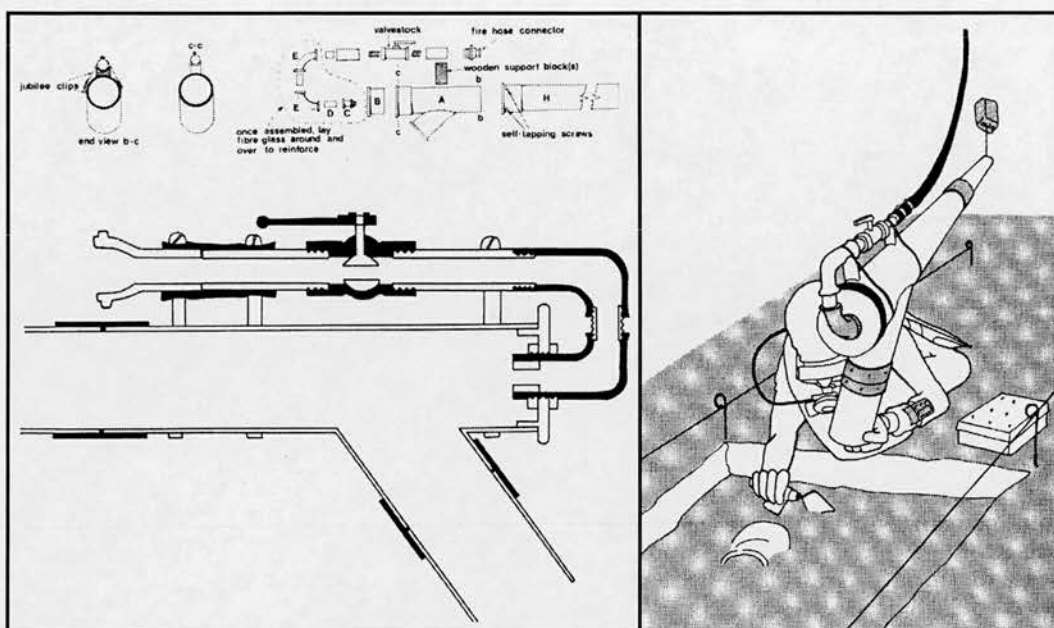


Figure 1.2 Schematic and application of a simple water dredge (after Dean *et al.* 1992). The dredge shown has a solid suction pipe, which can be replaced by a flexible hose for more control.

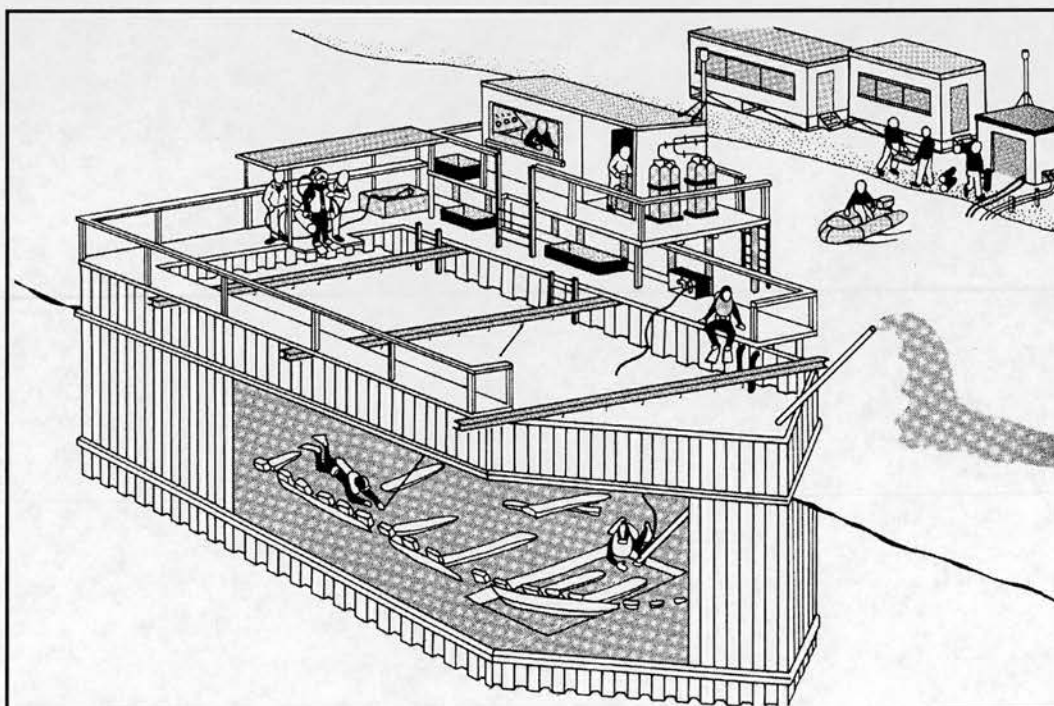


Figure 1.3 An example of a working platform and a cofferdam applied to a shipwreck site. Cofferdams can be used to keep a working area clear of current and debris, and could be applied to either a shipwreck site as shown above (after Dean *et al.* 1992) or submerged prehistoric cultural landscapes. This option, however, can be expensive, and difficult to install and maintain.



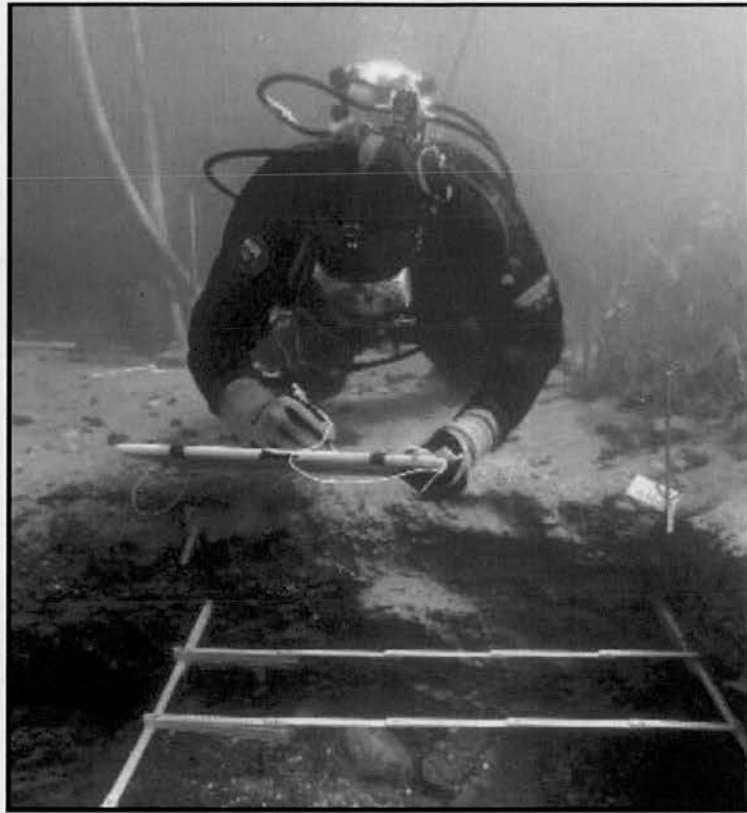


Figure 1.4 An underwater archaeologists diagrams a trench at a Mesolithic site in Wismar Bay, Germany (Curry 2006).



Figure 1.5 Shallow sites may allow for laser measurement of underwater features. This may be useful for spatial analysis (photo by Arne Hodalič).

material, a high pressure jet is used to clean surfaces in a way similar to an underwater fire-hose (St. John Wilkes 1971, fig. on p.180). This method, however useful for cleaning the hull of a submerged shipwreck, is ineffective when small, mobile objects are present. The preferred method in delicate areas is the application of a water dredge, which uses water pressure to create suction and remove silt and small objects (fig. 1.2; St. John Wilkes 1971, 222). A coarse sieve is then placed over the opening of the suction end of the dredge to keep larger pieces of material from clogging the hose. A collection bag may be placed at the end of the dredge, to ensure that smaller objects are not lost, which makes this a practical method for excavating submerged prehistoric landscapes. The logistical difficulty inherent in this technique is that in excavating in a silt-rich matrix, the collection bag can fill quickly with sediments, slow down excavation, and create copious amounts of material for sieving.

Green describes an additional cleaning device called a 'propwash': a coarse excavation tool used to clear away debris by directing the water flow from a boat's propeller. This method is not considered to be productive for underwater archaeologists, and has been used mainly by underwater treasure hunters to clear away sand or silt. Nevertheless, in shallow waters, the propwash technique can be used to clean surfaces with a compact outboard motor when small transportable material is not present (Green 1990). Finally, excavating heavy objects from submerged environments may require lifting bags, hooks and other equipment (St. John Wilkes 1971, fig. on p. 228).

Grids, frames, and even enclosures surrounding excavations can also be used in underwater excavation. A cofferdam may be constructed around an archaeological site, giving the option to either excavate the protected area underwater in the case of the Yorkshire shipwreck (Dean *et al.* 1992; fig. 1.3), or drain the area, as was exemplified in the Roskilde Fjord in the 1960's (Blot 1996). As is necessary in any archaeological fieldwork, documentation underwater is essential (Goggin 1960; Bass 1966; Muckelroy 1978; Dean *et al.* 1992), and underwater writing is done on plastic slates (e.g. Green 1990, photo 6.11). The recent introduction of digital photography

allows the archaeologist to photograph underwater and observe the results immediately, which has made an immediate impact on the quality of underwater photographic documentation since underwater photography can be difficult.

### **Preservation and conservation**

“The objective of all site recording is to preserve the contextual and other information that excavation will destroy” (Muckelroy 1980, 178), and, cautious excavation and preservation can limit the destruction of informative organic material preserved underwater. Preservation is often cited as a principle value of underwater archaeology (Muckelroy 1980; Flemming 1983; S.H. Andeson 1985; Fischer 1995; Bailey 2004) and conservation methods of material from underwater sites differs from that of land archaeology (Robinson 1981, 1998). Material, especially organic remains, but also metals, ceramics, and composite finds may be preserved for millennia in underwater environments (Muckelroy 1980; Robinson 1998). Thus a conservation strategy for excavated material is critical, because once removed from a waterlogged environment, materials may immediately begin to deteriorate. Conservation can cost more than the rest of an underwater archaeological project according to Muckelroy, thus a responsible excavator must make ample preparations and budget accordingly. The cost of conservation largely depends on the material in question. Conserving wood, for example, can be costly when using polyethylene glycol to replace water in the saturated cells with synthetic material, used to prevent the decomposition of the material’s structure (Muckelroy 1980). Thus, conservation of a large wooden ship will differ dramatically in cost from that of a submerged Neolithic food production site.

The preservation conditions may justify the cost and effort of underwater archaeology, though contributions of macroscopic material are not the sole value of underwater archaeological sites. Underwater sampling offers great potential for the study of both macroscopic and microscopic plant remains. Techniques in collecting, preserving and examining organic macro and micro-remains from submerged sites include coring, bilge mud collection, and sampling pollen and phytoliths from

storage vessels, coprolites, and resins (Gorham & Bryant 2001). Additionally, botanical material found underwater has been used as evidence in a variety of discussions including ancient subsistence (e.g. Galili *et al.* 1997; S.H. Andersen 1987) and climatic indicators (e.g. Christensen 1995, 1997). Stone Age sites in which rope and weaving have been recovered from submerged environments (S.H. Andersen 1985, Schlichtherle & Wahlster 1986, Fischer 1995; Lübke 2001) can provide cultural information concerning people and technology as well as environmental data including species availability and abundance.

## **Legislation**

In recent decades, steps have been taken to protect underwater archaeological sites around the world. Legislation of these sites generally depends on the sovereign state, which may have legislation in place to protect sites on land which differ from submerged archaeological sites (Dean *et al.* 1992). There may also be matters of legality based on international cooperation such as the European laws discussed in *Legal protection of the underwater cultural heritage* (Dromgoole 1999). Though Flemming and Max have listed diving laws for scientific diving in Australia, Austria, Canada, Chile, Germany, France, Ireland, Italy, Netherlands, New Zealand, Norway, Sweden, South Africa, UK, USA (Flemming & Max 1990, 13-14), this applies to general scientific diving projects and not to archaeology in particular. More specifically Delgado (1997), has listed several legal frameworks discussing underwater archaeology and legality of site disturbance, salvage and protection in *The encyclopedia of underwater and maritime archaeology*. Internationally these include: *the Abandoned Shipwreck Act of 1987* in the USA (p. 16), *the Australian Historic Shipwreck Act of 1976* (p. 44) and *the Protection of Wrecks Act* of the United Kingdom from 1973 (p. 441). Laws, however, fluctuate with political climate, and the need for greater protection of cultural material, and the underwater environment is clear. The National Heritage Act of 2002, for example, has extended the law to include all types of submerged sites within 12 miles of the English coast (Miles 2004). Legal parameters, established to protect material culture and



archaeological sites, are thus impossible to define universally, inasmuch as laws differ from country to country and must be addressed accordingly.<sup>11</sup>

### 1.3 Submerged Sites: Prehistoric and Maritime Archaeology

Historically, underwater archaeologists have been lumped together because of the method used to conduct archaeology, namely SCUBA diving (Lenihan 1983). The paradigm, however, is dangerous to underwater archaeologists who may fall into the trap of non-specialization within the greater field of archaeology generally divided by time period or region. The difference in underwater site type often corresponds to age. Apart from a few examples of Bronze age sites in the eastern Mediterranean (Bass 1972), shipwreck sites are mainly historic or Classical (Hellenistic or Roman) in age (Muckelroy 1980; Delgado 1997; McGrail 2002). Earlier examples of ships in prehistory come from indirect evidence such as depictions in art (e.g. Stölting 1997; McGrail 2002), transportation of foreign materials (Bass 1972; Farr 2006) or human occupation of deep water islands (Forenbaher *et al.* 1994; Forenbaher & Kaiser 2005). Of the known underwater archaeological sites in Europe the vast majority are not prehistoric (Muckelroy 1980; Delgado 1997), and the study of submerged prehistory has thus been relegated to the fringes of underwater archaeology (fig. 1.1; Muckelroy 1978).

The lack of documented submerged Mesolithic and Neolithic sites is partially due to the nature of the sites themselves, but also a result of an existing bias within the prehistoric archaeological community. Bailey (2004, 3) states that as prehistoric archaeologists, “we are part of a much larger community which in general is far from convinced of the virtues of investigating submerged prehistoric archaeology, inclined to regard it as the playground of diving enthusiasts or an extremely costly enterprise with very uncertain rewards.” Bailey maintains that there are four common preconceptions and skepticisms of the prehistoric archaeological community regarding the value of underwater archaeological research of prehistoric

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<sup>11</sup> Discussions regarding legal aspects of the original underwater archaeological survey are discussed in section two and three of this dissertation regarding the laws in Slovenia and Croatia.

sites: 1) Underwater remains have not been preserved, are too difficult or too costly to retrieve. 2) Finds from underwater sites are unlikely to provide information that could not be more easily obtained on land. 3) Coastal settlement and marine paleoeconomies are marginal to the main patterns of world prehistory. 4) The search for underwater civilizations advocated by amateur enthusiasts is a further symptom of a marginal field of study. Citing historically recognized researchers including Darwin and Childe, Bailey discusses biased depictions of coastal populations of hunter-gatherers both through ethnographic examples, and within prehistoric archaeology (Bailey 2004).

Coastal importance to Stone Age hunter-gatherer populations has recently been addressed by prehistorians (Rowley-Conwy 1983; van Andel 1989; Larsson 1995; Bailey 2004). Advantages of coastal living<sup>12</sup> are simplified as follows: 1) Transportation and communication of people and culture. This encompasses trade and social activities, and includes travel by sea through migrations of populations and material culture. 2) Access to food resources, specifically the high availability and variety of marine and terrestrial plants and animals. 3) Access to other (non-food) resources. This includes fresh water in high water-table environments and at coastal river-mouths, as well as available material for tool production. Examples of these materials include pebbles and river rocks, driftwood, and other organic materials used for structures, tools and fuel.

While the traditional archaeological community may have historically underestimated underwater methodology, so too has the underwater archaeological community shown limited interest in prehistoric, particularly Stone Age archaeology underwater. Despite the goal to produce a “comprehensive encyclopedia dealing with archaeology underwater” (Delgado 1997, 6), Delgado has listed only fourteen topics classified as “prehistoric archaeological sites”. Of these topics, which include broad-scale themes ‘Lithic Artefacts’, ‘Prehistoric archaeology’, ‘Quaternary coastlines and land bridges’ and ‘Shell Middens’, there are only three specific

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<sup>12</sup> This simplification is based on Bailey (2004) who has listed eight reasons of coastal advantages for hunter-gatherers in prehistory.

examples which relate to European prehistoric archaeology. These are ‘crannogs’, ‘Lake Neuchâtel’ and ‘Lake Zürich’. Because the lake sites can be consolidated within ‘Central European Lake Dwellings’<sup>13</sup>, only two prehistoric archaeological subjects are listed in the *Encyclopedia of underwater and maritime archaeology*. This limited prehistoric contribution stands in comparison to over 300 examples of individual shipwrecks listed in the same section (Delgado 1997, 6, 13). This point does not serve to disparage the contributions of maritime archaeology, but rather to illustrate that a bias exists within the underwater archaeological community. Thus, while traditional archaeologists may ignore underwater methodology, underwater archaeology has historically focused very little attention on submerged prehistoric discovery.<sup>14</sup>

### **Underwater site taphonomy: The processes of submergence**

There are four general ways an archaeological site can become submerged (Goggin 1960).<sup>15</sup> 1) Deposition, whereby a site is created by human deposition or loss of material. This includes the loss of individual objects or the sinking of a maritime vessel. 2) Submergence due to having been built on, in, or near water. This type of site would have been destroyed or deteriorated into the water. This may include sites such as Crannogs (e.g. Dixon 2004) which were built over lochs in Scotland and Ireland and used throughout prehistoric and more recent times. 3) Votive or Sacrificial sites. This category includes votive offerings, such as Neolithic daggers found in Denmark (Fischer 2004), and has also been referred to as ‘shrine sites’ (Goggin 1960). 4) Submerged cultural landscapes. This includes sites built or

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<sup>13</sup> This would be consistent within Delgado’s own classification system.

<sup>14</sup> Exceptions to this, however, are Masters & Flemming (1983), Fischer (1995) Fischer & Pedersen (1997), Schlichtherle & Wahlster (1986), Schlichtherle (1997), von Schmettow *et al.* (2000), and Flemming (2004), as well as underwater archaeological periodicals which maintain the importance of submerged prehistory and the need for prehistorians to recognize the potential of underwater archaeology. Particularly the German language periodical, *NAU*, as well as some contributions from the *International Journal of Nautical Archaeology* and *Journal of Maritime Archaeology* (multiple references throughout this dissertation). The new English language periodical the *Journal of Maritime Archaeology*, which began in 2006, has also discussed prehistoric elements in its first volume.

<sup>15</sup> Goggin’s description of site definition originally included ‘discarded’ and ‘lost’ material in a single category and ‘shipwrecks’ as its own separate category. Thus, the four categories stated herein are adaptations of Goggin as redefined by the author.



occupied on dry land, which were later inundated by rising water levels caused by changes in natural environment (e.g. Flemming 1983; Fischer 1995; Schlichtherle 1997; Hartz & Lübke 2006) or tectonic events such as the earthquake which destroyed the coastal town of Port Royal in 1692 (Marx 1980).

### **Coastal sites versus submerged lake and river sites**

There is a need to establish the difference between sites located in coastal zones, and sites found in lakes and rivers. While similar technological methods for survey and excavation may be applied within these different environments, lakes and rivers present different conditions of submergence and therefore the archaeological implications are often different to those coastal sites. A separation of site types can also be made based on the type of aquatic body in which an archaeological site is preserved. River sites have been recently discussed for their own contributions and methodological challenges (e.g. Szabó 2000; Bonnamour 2004; Gaspari 2003, 2006). Inland lake sites also possess unique conditions both for preservation, as well as excavation practice; lake sites are historically significant for their contribution to underwater archaeological methodology (e.g. Ruoff 1997; Schlichtherle 1997; Menotti 2001).

Submerged sites found in inland lakes answer different archaeological questions about the populations, who inhabited them, illustrated by Central European Alpine Lake sites (e.g. Arnold 1990; Schlichtherle 1997; Menotti 2001). Lake and river sites may offer artifacts, which represent activities found at both inland bodies of water and coastal seaside environments. These may include evidence of Neolithic boats (e.g. Fugazzola Delpino 1995), as well as ancient fishing material (e.g. Königer & Lübke 2001). Prehistoric archaeology from inland freshwater sites can be used to suggest available knowledge and technologies with contemporary coastal zones, such as seafaring (e.g. Farr 2006). While lake and river sites are discussed in this dissertation for their regional, methodological and historical significance, coastal zones are emphasized to illustrate underwater methodology as applied to submerged cultural landscapes directly affected by early Holocene sea level rise.

The following discussion on sea level rise will also address the question of coastal site taphonomy with regards to sites from the late Pleistocene and early Holocene. Examples of the variety of sites and locations of underwater archaeological material will also be addressed later in this chapter.

#### 1.4 Sea Level Rise in the Late Quaternary and Submerged Site Survival

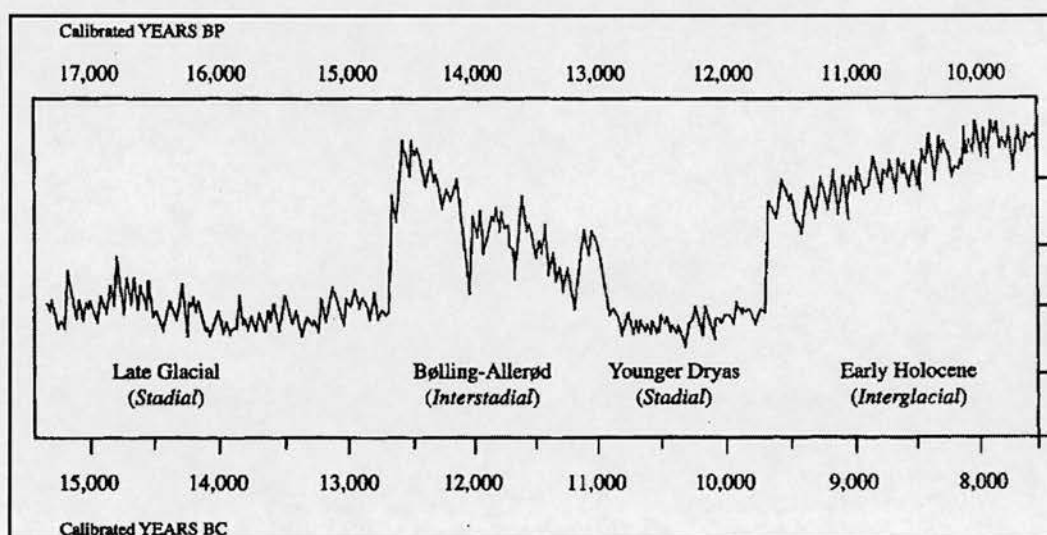


Figure 1.6 Global temperature fluctuations during the Pleistocene-Holocene transition (after Sherratt *et al.* 1997).<sup>16</sup>

The topic of *late quaternary sea-level changes* (van Andel 1989), has been researched in a multi-disciplinary manner and discussed in recent decades relevant to coastal archaeology (e.g. Flemming *et al.* 1968, 1978, 1983; van Andel *et al.* 1982, 1989, 1990; Pirazzoli 1985, 1991; 1996; Lambeck *et al.* 1998, 2002, 2004). The impact on archaeological sites during the early Holocene cannot be overlooked. It is widely accepted within the archaeological community that a global temperature increase during the Bølling-Allerød interstadial and the early Holocene Interglacial periods dramatically affected both the environment and its human occupants.

<sup>16</sup> Sherratt cites Alley *et al.* (1993)

Measuring ancient sea levels can be carried out by examining biological species such as corals (Fairbanks *et al.* 1989), or mollusks (Shakelton *et al.* 1980, 1988) that lived in and around the littoral fringes or mid littoral zones. Geological indicators such as notches, erosion benches and platforms can also provide evidence for sea level change (Pirazolli 1996). Bioerosion features such as marks left by supralittoral plant borers indicate a lower sea level, while borer shells found in rocks above sea level can indicate sea level drop, although with limited accuracy (Pirazolli 1996).

Submerged remains of forests are an example of supralittoral plant life, which can be found preserved after being inundated by rising seas (e.g. Fischer 1997) or lakes (e.g. Dixon 2006). Sedimentary shores such as mud, sand, pebbles or shells can be identified by granulometric, biostratigraphic and physico-chemical evidence; grain size of marine deposits largely depend on the amount of energy and resulting coastal impact directly formed by the contact with water in the nearshore environment (Pirazolli 1996).

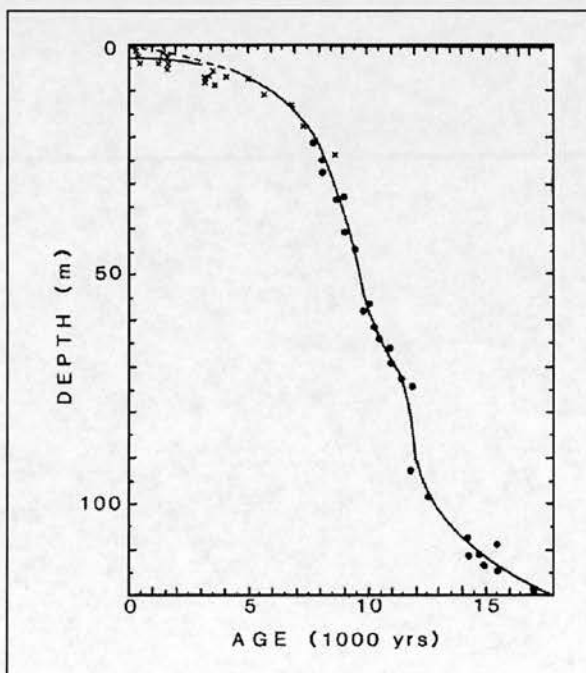
It has been suggested that modern knowledge of global sea levels is sufficient to reconstruct examples of late quaternary coastal paleogeography. "Complex as the subject is, we know the history of sea level over the last 125,000 years well enough to enable us to take its chronology and its impact on late Quaternary shoreline positions into account in a reasonably precise manner." (van Andel 1989, 733).

Based on the data available, van Andel (1989, fig 3.) has reconstructed Mediterranean coastlines at the last glacial maximum and early Holocene. van Andel however later amended his article (van Andel 1990), after the publication of *A 17,000-year glacio-eustatic sea level record: influence of glacial melting rates on the Younger Dryas event and deep-ocean circulation* (Fairbanks *et al.* 1989).

In this benchmark study, *Acropora palmatta*, a coral that lives in shallow waters, was identified in core samples from the Barbados shelf. The results produced by Fairbanks *et al.* led van Andel (1990) to print a simplified version of the newly updated sea level curve (fig. 1.7) which indicates a slow rise from -120m at c.17,000 BP, followed by a very fast rise of 24m in under 1000 years beginning c.12,500 BP. During the Younger Dryas, the rate slowed. Sea level rise accelerated again from the

end of the Younger Dryas until c.8000 BP. when the rate slows down again. At this time sea levels are recorded to have been approximately 25m lower than today. This data from the Barbados shelf has been used to suggest sea level curves globally, however, a local application, as stated by van Andel, “requires the adjustments imposed by gravitation attraction of ice sheets, isostatic compensation, and local tectonics in order to provide the necessary fine precision, but it does furnish the global base-line for regional paleogeographic purposes...” (van Andel 1990, 2).

Pirazzoli (1996) concurs that the water balance, on a global scale, would have been significantly affected by temperatures and climate between 18,000 – 6,000 years ago. However, like van Andel, Pirazzoli expresses concern about a global approach, and cites localized climatic changes as well as other regional factors, which may have impacted coastal environments. “Over a local scale, possible causes of relative sea-level oscillations are even more numerous because they include, in addition to all global and regional causes, many kinds of possible local vertical displacements resulting from small-scale hydro-isostatic, tectonic, or volcanic processes, sediment compaction, tidal changes, and climatic changes.” (Pirazzoli 1996, 96). Thus, while



a rise in sea levels is likely to have occurred globally after the deglaciation, caution must be exercised in extrapolating these data to other locations, and the need for regional, and local considerations must not be overlooked.

Figure 1.7 Global sea-level rise data by Fairbanks (1989) as simplified by van Andel (1990).



In southern Scandinavia, where extensive underwater archaeology has been conducted (discussed in detail in the following chapter), Mesolithic sites have been well preserved underwater due to favourable conditions of transgression, and preservation. In fig. 1.8, an illustration depicting the stages of transgression at a typical site in southern Scandinavia, the artist has shown the stages of transgression prior to archaeological discovery by a diver (Malm 1995). The area immediately above the shore is inhabited by coastal hunter gatherers and refuse is disposed or later displaced to the seabed. Some material is preserved *in situ*, in the actual habitation area, however many of the artifacts have been transported by the rising water level. Sea levels rise over time displaces the inhabitants and creates the conditions for preservation under marine sediments and aquatic plant life. Finally, underwater archaeologists discover sites in two examples of conditions according to this model: The first image presents a site that has been submerged and lies underneath sediment and Eel grass. The plants hold the seabed material together. In the second image, the diver discovers an eroded bank that is releasing archaeological material. This is caused by currents, seabed composition, and the fewer sea plants binding the underwater soils. This situation also presents itself as an issue for the management of vulnerable cultural material, and the destruction of submerged cultural heritage.

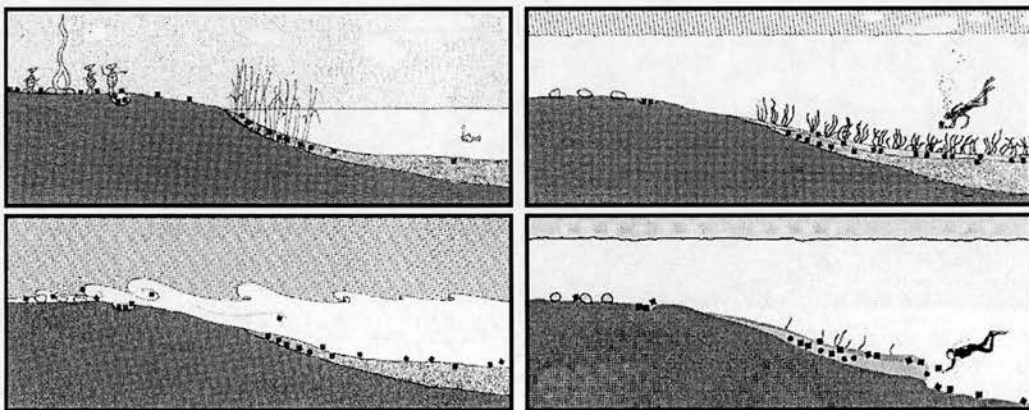


Figure 1.8 Stages in the transgression of a coastal Stone Age settlement in southern Scandinavia (illustration by H.V. Jørgensen, after Malm 1995).



Sea level rise during the early Holocene would have presumably disturbed a significant amount of coastal archaeological material, and thus there exists an important relationship between underwater site survival and early Holocene sea level rise. Areas where sites are located must be considered for their archaeological preservation, and submerged site process is of primary concern to the prehistoric archaeological potential in the submarine environment. While there are a number of variables and factors that may allow for preservation, the commonality of protected environments, shelter from exposure to high-energy, destructive elements are somewhat universal. The circumstances by which such protection is afforded to an archaeological site do however vary greatly. Flemming (1983) has categorized the environmental conditions in which underwater prehistoric sites have been discovered: lagoons (including ria and estuaries), sheltered alluvial coast, accumulating beach, submerged sea caves and islands and archipelagos.

Flemming also notes that “no single factor in the geomorphology of the coastal zone is necessary or sufficient to ensure preservation of archaeological remains underwater, and the same is true of tidal, current, and wave exposure...” (p. 164). Thus, there are a number of factors that may allow for the preservation of submerged archaeological material and the conditions of site formation, transgression, and preservation will vary. On a regional scale, conditions such as swell, tides, salinity, exposure to the elements, and human disturbance can all play a part in impacting site survival. Other variables include geological factors such as soil composition, as well as tectonic and isostatic changes in landscape.

Indeed, it can be said that sites that have had the least exposure to the immediate disturbance caused by transgression will have a better chance for survival. Sites where transgressions happened very quickly, thus sheltering the archaeological material from centuries of potential destructive battering are presumed to be better examples of such conditions for positive preservation. The difficulty with the assertion that site survival in areas, where a quick transgression occurred, are desirable for preservation, is that sea level rise data does not allow for a very precise account in a given local environment. Even the more comprehensive localized sea

level rise data (e.g. Christensen 1995) are insufficient to state with certainty that an individual site was transgressed over a period of two years rather than twenty.

In fact, sea level data that are used to identify paleolandscapes must be acknowledged as averages, whereby the archaeologist must infer that there would have been local and temporal variation, and that sea level data, such as that produced by Fairbanks (1989) or Lambeck *et al.* (2004), cannot suggest, with certainty, the exact time of the process of site-submergence. One must exercise caution and appreciate the precision of such sea-level data. This is not to state, however, that such averages cannot be used within their appropriate contexts, but does in fact lead to the suggestion that a simple graphical reconstruction (*ie.* Fig. 1.8) is an idealistic representation that is almost certainly an over-simplified version of the process. Other more detailed reconstructions of transgressed prehistoric landscapes (e.g. Hansen 1995, fig. 4) show that transgressions and submerged landscapes are complicated physical processes, and sites thereon will undoubtedly be impacted in a number of ways which displace, destroy and also preserve natural and archaeological material.

### **1.5 Submerged Stone Age Sites in Europe**

Although the underwater archaeology conducted in the coastal zones of Europe during the past half century has been mainly historic, or Classical, there has been a concerted effort by a few underwater archaeologists to search for submerged Stone Age sites. Submerged evidence of prehistoric human occupation of coastal zones has frequently been discussed theoretically but because of bias within the community “it has usually been assumed that no human artefacts or settlement sites would survive the rising transgression of sea level.” (Flemming 1983, 135). While predictive model studies, such as that discussed by Fischer (1993, 1995) have been developed to actively seek out submerged prehistoric material, Flemming continues that “it is equally important to consider the field examples of material found underwater in the last 10-20 years.” During the late 20<sup>th</sup> century, stone walls, floors, hearths, ceramics, flora, fauna, bones tools, lithic scatters, organic material including hafted tools, and

other artifacts have been discovered in submerged environments throughout Europe (e.g. Flemming 1983; Grøn & Skaarup 1991; Galili *et al.* 1993; Fischer 1995, Hartz & Lübke 2006).

The examples in this chapter are not put forth within the context of detailed regional archaeological nor paleoenvironmental chronology, however, they serve to demonstrate the submerged prehistoric evidence of Europe and the types of sites where underwater Stone Age survey and excavation have yielded significant archaeological results. These are sites which have been submerged due mainly to rising seas during the late Pleistocene and early Holocene sea as described above, however examples from lake sites of central Europe, and the Crannog sites of Scotland are also included for their historical and methodological roles. Underwater Stone Age sites from Scandinavia and sites from the eastern Adriatic region are found later in this dissertation. Two sites from Scotland and Cyprus, are discussed for the above mentioned reasons as well as for the author's direct involvement in the primary fieldwork. The following submerged prehistoric sites are discussed geographically and categorized by modern political borders.

## **France**

Between 1968 and 1980 as part of a focused effort on underwater archaeological survey, studies were carried out in the underwater caves of the Mediterranean littoral by Bonifay, Courtin, and de Lumley (Clottes *et al.* 1992). Submerged caves in the area such as Grotte des Tremies at Cassis, Grotte du Figuier, Grotte de la Triperie now exist beneath more than 20m of water. The latter two caves were discovered by Henri Cosquer in the late 1970's, although no direct evidence of prehistoric human occupation was noted. Another cave, found in 1985 was discovered to have been occupied by Paleolithic groups, when cave paintings were first observed in 1991. This cave, now famously named after its discoverer, is discussed in detail in Clottes *et al.* (1992), which is paraphrased below.

Cosquer cave (*Grotte Cosquer*) is located 12 km southeast of Marseilles, on Cap Morgiou, south of Point de la Voile. The opening, positioned in a cliff of Urgonian limestone, lies at 37m below the present sea level. The narrow entrance is 1.3m high, and 2.25m wide. The submerged tunnel is 175m long and 2m to 3m wide and slopes steadily upward, climbing toward the chambers (fig. 1.8). The chambers, which are partially submerged, contain submerged stalagmites created before the cave was flooded. There is no access to the exterior of the cave presently; however there are bat skeletons, which may indicate that there was access in the past.

Paleolithic paintings were present mainly in the western and eastern part of the chamber, found on walls and ceiling. There are outlines of hands, and images of fauna, including horse, bison, feline (*megaceros*) ibex, and penguins. Engravings of fauna and finger-marks are also found throughout the chamber. Charcoal remains found along the crevices and ledges, and two circular hearths, 30cm in diameter were discovered partially calcified. No bone or lithic materials were recorded from this site upon survey. A single radiocarbon sample taken from charcoal was dated to 19,900 BC (18,440±440 BP, LY-5558). While not recovered in great quantity, pollen samples from the cave have offered data consistent with that of the region during the late Pleistocene.

Since the archaeological material was discovered above modern sea level in Cosquer cave, the site does not demonstrate an application of underwater archaeological methodology for sampling and excavation, and although an underwater survey was conducted, it yielded no finds. While the archaeological finds are found in the dry sections of the cave, the site is defined by the submerged entrance, which has preserved the Paleolithic features and ensured its protection from modern disturbances. Because Paleolithic cave art in France and Spain recurs as a focal point of criticism and scrutiny, the question of authenticity is addressed by Clottes *et al.* Authenticity of the site has been determined not only by the submerged characteristics, but also through calcite deposits found to have formed over several of the paintings. Calcite forms very slowly and can thus be used as an indication of age. The engravings are cut cleanly into the surface, and are consistent in color with



the matrix and lack of any burring. Also, under magnification, crystals can be observed in the interior of the engravings. This evidence would seem to dispel any theory of recent creation. It is for these reasons Clottes *et al.* conclude that the site is authentic and its contribution to the record of Paleolithic cave art in France has been accepted.

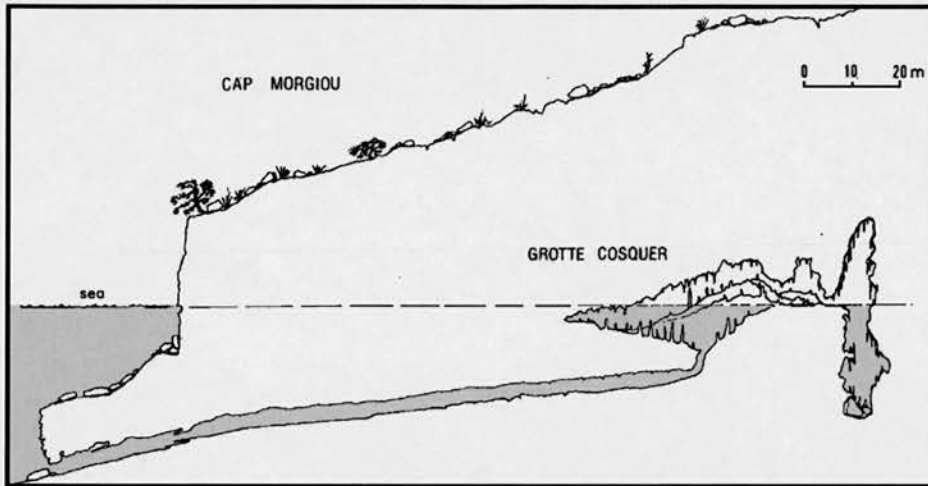


Figure 1.9 Diagram of the cross section of Cosquer Cave (after Clottes *et al.* 1992)

Elsewhere in France, Geddes *et al.* (1983) have described an early Neolithic occupation site, radiocarbon dated to 5700 BC ( $6800 \pm 90$  BP, MC-788), on the deltaic levee in Roussilon. Submerged by the rising Mediterranean, the site at the Point de la Courège, Aude, was discovered in 1972 during the dredging of a new channel to Port Leucate. The exact location of the site was never determined nor was the site stratigraphically recorded, due to the destructive excavation by non-archaeologists. It is unfortunate that no detailed information from the archaeological deposit is available. This site can be classified as an archaeological rescue interpretation of an industrial salvage. Additionally, while animal bones were discovered, including domesticates of sheep and cattle, and wild type boar, deer, auroch, and birds, non-human deposition of faunal material cannot be ruled out. Much of the associated data has been lost as a result of the conditions of discovery.

Archaeologists at the site of le Point de la Courège employed wet sieving to recover a dredged collection of artifacts which included faunal remains, lithic and bone



tools, and ceramic material (Geddes *et al.* 1983). The ceramic and lithic material appear to be of a single phase as they lack much variety in typology. The early Impressed Ware occupation (Cardial-Impresso) is represented in the assemblage of sub-spherical bowls, spherical necked vases and cylindrical jugs. Typological dates applied to this group imply that the ceramic material is dated to c.7200 – 6700 BP according to Geddes *et al.* Although the site was excavated by dredging, radiocarbon samples were taken from four charcoal samples recovered. The dates given span a large time scale; The first date of 5700 BC (6800±90 BP, MC-788) has been accepted as consistent with the artifacts. Two later dates 4235 BC and 1490 BC (5410±140 BP, Gif-2747], 3210±140 BP, Gif-2748) have been rejected, while a fourth date, 4780 BC (5900±140 BP, Gif-2749) is questionable (Geddes *et al.* 1983). All dates must be regarded as speculative at best, as they come from charcoal which cannot be directly associated with the archaeological material. Thus, despite the intentions of the archaeologists to date this site through absolute methods, typological dating appears to be the most appropriate method of establishing the age of the site at le Point de la Courège.

The absence of small fish from the sieved material has been used to suggest the implementation of line fishing, rather than nets. The open sea fishing activity is represented by Swordfish (*Xiphias gladius*) although the most common fish species is Seabream (*Sparus aurata*). In the fish bone assemblage, large amount of cranial remains, particularly the mandible, are present when compared to vertebrae. Thus, it is suggested that le Point de la Courège was a fish processing site of the early Neolithic. Bone knives present can likely be associated with fish processing, and seem to strengthen this assertion. The evidence of charcoal may also suggest the cooking and smoking of fish, possibly for storage (Geddes *et al.* 1983).

Also in southern France, on the bed of the Thau lagoon, remains of stone tools and foundations of walls were found. Protected, mainly due to the overlaying sand bars,

the items were discovered at depths between 2m and 5m (Flemming 1983).<sup>17</sup> Dredging in the Étang de Salses near Leucate has produced items, which are typologically dated to the 3<sup>rd</sup> Millennium BC, and middle Neolithic. In the case of the remains found in Thau, divers discovered the Neolithic, as well as later Bronze aged materials while searching for Roman and Greek shipwrecks (Flemming 1983).

Prehistoric underwater sites have also been recorded in Brittany & northern France. “Numerous Traces of human occupation (megaliths, settlements, salt sites) are now partly underwater or embedded in peat or mud. They attest to an important occupation of the Armorican coast during the postglacial, and occupation which is partly linked to the shoreline evolution.” (Progent *et al.* 1983). Standing stones are found at Er Lannic in the Morbihan Lagoon. Foreshore and outer half of the circle lie below sea level (Flemming 1983). Near Cap Levi, 10km from Cherbourg, erosion has exposed Middle Paleolithic material where the coast is subject to fetch from the English channel. The site is found at a depth of 17m to 20m and is a submerged river valley flanked by lagoon deposition. Those deposits originally covered and protected the ancient artifacts, which consist mainly of worked flints. However, currents have eroded the protective deposition, and lithic material was exposed, falling onto the sea floor. In total 2552 flints have been removed from this site, which Flemming has classified environmentally to be both estuarine and an open accumulating beach. The archaeological material was discovered by divers after it was exposed by erosion of the submerged paleosol (Flemming 1983). This process of site exposure is found at sites throughout northern Europe, and will be discussed in greater detail.

## **Great Britain**

Surrounded by water, Great Britain would seem to be an obvious location for submerged Stone Age archaeology. However two important variables impact the coastal prehistoric archaeology in Britain: large tidal swings and the high-energy coastlines. The latter, while not obliterating all chance of site discovery, can be

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<sup>17</sup> Flemming references Fonquerle (1982) on page 139 and Crawford (1927), Gigot, and Prigent (1978) on page 141.

negative for obvious destructive and practical reasons. The tidal activity in Britain does provide an interesting scenario, which has led to a specialization in wetland archaeology (e.g. Coles & Coles 1996). Tidal swings in Great Britain are amongst the largest in the world, and in extremes can swing greater than 10m.<sup>18</sup> Because of the tidal activity, marginal littoral zones, which are not steep in physical nature, are frequently exposed and accessible to traditional archaeologists during the low tide. As early as the mid 19<sup>th</sup> Century, British archaeologists discovered submerged environments and cultural material in these tidal zones. Dawkins has described early discovery of Stone Age material in England; “The submarine forest exposed between the tide-marks on the coast of West Somerset has long been known...At this point between tides, where the angular fragments began to appear, the flint chippings were found.” (Dawkins 1870, 141-2).

Despite coastal variations, tidal ranges, and high-energy zones, there are submerged Stone Age sites in Great Britain, which have been discovered and recorded using underwater archaeological practice. Material from the North Sea include both archaeological and paleozoological remains of animals such as mammoth from >40,000 years in age (Van Kolfschoten & Van Essen 2004) and cultural material from the late Pleistocene and early Holocene. Mesolithic stone and bone implements which have been dredged up from the sea bed, and recovered by underwater archaeological fieldwork have also been discovered in British waters (e.g. Momber 2000, 2005). In addition to the sites themselves, recent discussions described in *Submarine prehistoric archaeology of the North Sea* (Flemming ed. 2004) address the definition of submerged prehistory as a natural or cultural science (Firth 2004), and describe the difficulty managing submerged prehistory (Oxley 2004). Underwater methodology and archaeological contributions from the submerged Stone Age of Great Britain are described below.

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<sup>18</sup> More information on tides in the United Kingdom can be obtained from the United Kingdom Hydrographic Office, <http://www.ukho.gov.uk>

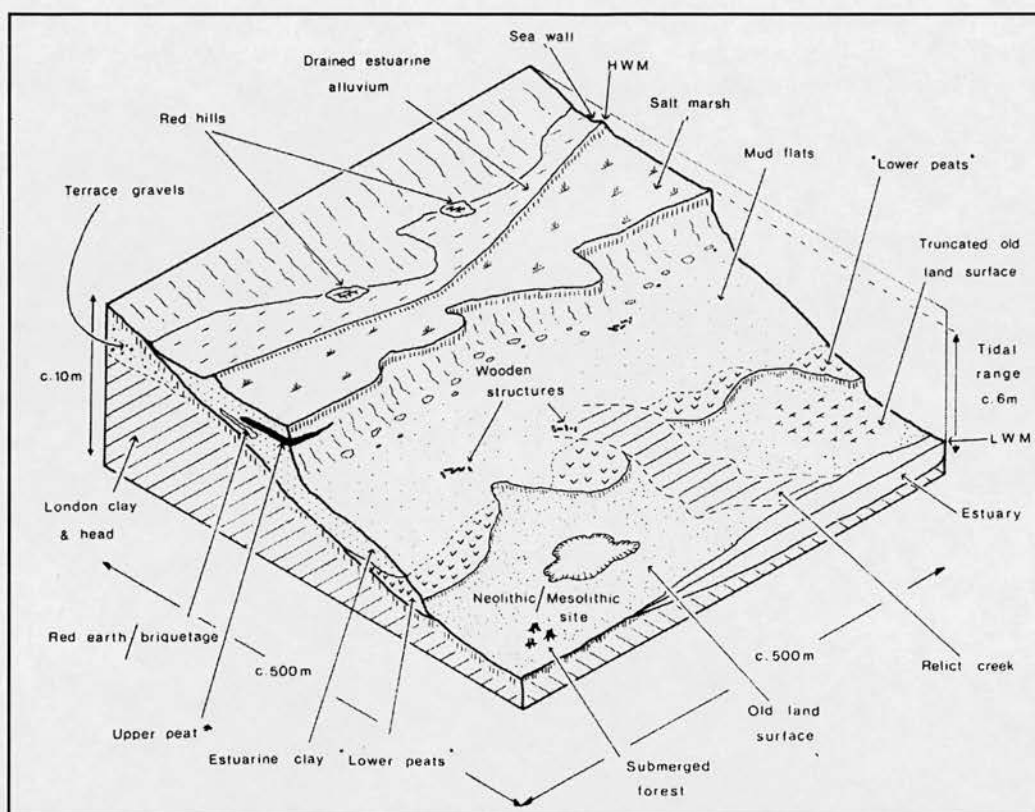


Figure 1.10 An example of a typical section of an Essex estuary, including ancient land surface (paleosol), overlaying sedimentary deposits, and an archaeological site in the mean tidal zone. This is an example of a wetland site, which is generally excavated through specialized practice, not underwater methodology (after Essex Archaeology 1995).

### Isle of Wight & the Solent: Bouldnor Cliff

In southern England, Stone Age flint artifacts have been discovered by fishermen and underwater archaeologists in the channel known as the Solent, located between the Isle of Wight and the mainland (Momber 2000). The Isle of Wight has been the source of Stone Age finds on land since as early as the 1890's, and the location of significant archaeological survey during the 1960's. The earliest indications of the submerged cultural landscape in the Solent were identified in 1976, when local fishermen discovered timbers and peat (Momber 2000, 2004). These sources were investigated and in 1985 the material was traced to the foot of an underwater cliff on the western side of the Solent. Several flint artifacts were uncovered underwater, although they were discovered by fishermen and without context. The area under Bouldnor Cliff was eventually identified for archaeological survey (Momber 2004).



At that time, the remains of trees and root systems were also documented in the band of peat eroding from the submerged cliff (Momber 2000).



Figure 1.11 Prior to 1997, the only Stone Age artifacts from the Solent had been recovered by fishermen, as pictured (Momber 2000). These were initial indicators that submerged cultural landscapes may be found during archaeological survey.

In 1997, the European LIFE project funded archaeological and paleoenvironmental fieldwork of this submerged site. Core sampling was conducted in the peat deposits, and underwater survey was carried out. Since the survey required diving in low visibility environment, it was time-intensive and required several divers to survey the peat layers and surrounding areas (Momber 2000). Submerged stumps and timbers were recorded in this initial survey. Also recorded in this survey were peat layers, which created overhanging ledges at 4m, 5m and 11m to 12m depth.<sup>19</sup> The peat outcrops themselves were later dated by radiocarbon determinations to c.4380 BC (6475-6280 BP), c.4680 BC (6870-6485 BP) and c.6460 BC (8565-8345 BP) respectively (Momber 2004).<sup>20</sup>

<sup>19</sup> Momber (2000, 2004, 2005) lists all depths as compared with British Ordinance Survey levels. This is presumably due to the large tidal swing commonly found along the coasts of Great Britain.

<sup>20</sup> Momber has listed these dates in cal BP with windows of occurrence: 6475-6280 cal BP (Beta-140102) 6870-6485 (Beta-140103) 8565-8345 cal BP (Beta-140104). The first date which Momber cites in 2000 for the lower deposit is 7500-7000 cal BP. This has been updated in Momber (2004, 2005) with a date of 8000-8500 BP as the date for the lowest peat horizon.



The survey along the cliff face was conducted by drift diving (a type of SCUBA dive which uses currents as a natural propulsion) and followed the peat horizons for over a kilometer (Momber 2000). During the search, culturally worked flint was discovered at the south west corner of the site. The flints appeared to have been recently uncovered as a result of lobster burrows in the peat, and were discovered on the seabed, having fallen out of the primary matrix. A total of 35 pieces of flint, mainly debitage, were discovered in two areas 5m apart. Since the excavation was caused by bioturbation, all contextual evidence and provenience for the initial finds were not available (Momber 2000). Two core samples conducted just 20cm into the peat yielded additional flint finds. In May of 2000, after this initial discovery, a test trench was excavated and yielded archaeological material from the organic sandy deposit below the lowest peat horizon (Momber 2004). Over 300 pieces of worked and burnt flint were recovered from this excavation. Also recorded during later surveys by divers from the Hampshire & Wight Trust for Maritime Archaeology (HWTMA) was a feature which has been described as either a hearth, or an oven-pit dating to c.6750 BC (8000-9500 BP) (Momber 2005). Based on the material found in the submerged environment of the Solent, it is likely that future investigations could yield rich cultural deposits, indicating that the region is ripe for future study.

### **Northeast England: Brown's Bay, Tynemouth**

Recent surveys conducted near the Tynemouth river outlet have produced Mesolithic flint tools (Moran 2005).<sup>21</sup> The bay faces north northeast into the North Sea making it a high energy zone and attracting fetch from as far north as the Arctic. Despite this, a number of worked flints were collected from Brown's Bay. Two reefs, described by Moran as the inner and outer reefs define the bay, which contains a number of shipwrecks from the past century. The area is known to be abundant in flint, and has been suggested as a good source of resource exploitation, in line with the previously described theories discussed by Bailey (2004).

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<sup>21</sup> L. Moran wrote his master's dissertation, while at Newcastle University, on the submerged artefacts from Brown's Bay, Tynemouth, England.

The initial discovery of the site was made in 2003 when divers working with the project 'The Potential for Submerged Prehistoric Sites of the North East Coast' discovered worked flint in the bay (Moran 2005). After the initial discovery was made, the fieldwork goals were set to establish the extent of the surface finds, collect and record archaeological material and establish the topography of the modern marine environment to further examine the taphonomic processes of the site. Sub-seabed material was not sought during this fieldwork, which was limited to surface survey without excavation. Because divers in Brown's Bay be subjected to conditions of poor visibility, the progress was slow. In total ten weeks of diving with five volunteer divers were carried out. Of the approximately 200 flint samples recovered from Brown's Bay in the 2003 season 31 have been identified as cultural (Moran 2005, appendix) of which, six were classed as cores, four blades, four 'tools' and 17 pieces of debitage. The material was recovered from three separate locations at depths ranging from 2m to 8m.

### **The submerged Neolithic woodland in Loch Tay, Scotland**

Crannog sites of Scotland and Ireland have been studied by archaeologists since the 19<sup>th</sup> Century (Munro 1882, 1886; Wood-Martin 1886). These artificial islands were used in Scotland from the Neolithic through the 17<sup>th</sup> Century (Henderson 1998) and have been the topic of extensive research during the past two centuries (e.g. Morrison 1980; Henderson 1998, Dixon 2004). Of the earliest known contributions, J. Mackinlay presented a paper in 1812 discussing observations from Dhu Loch. J. Robertson read a paper in 1857 entitled "*Notices of the Isle of the Loch of Banchory, the Isle of Loch Canmor, and other examples of artificial or stockade islands called crannogs in Ireland, and Keltischen Pfahlbauten in Switzerland*" (Munro 1886, 456). W.R. Wilde is credited with "the first systematic examination of any of the Irish crannogs. This was as early as 1839, and consequently preceded the discovery of the Swiss lake-dwellings by fifteen years." (p. 453). Munro cites the use of the word 'crannog' in a Scottish context in the 1863 publication by J. Gigor "*Two ancient lake-dwellings or crannogs in the Loch of the Clans, Nairnshire*." (p. 456).

Loch Tay in Scotland has been the an area of crannog archaeology for over 25 years (Dixon 2004). There are 18 crannogs in Loch Tay (Dixon 2004, distribution map p.21), including the late Bronze age site of Oakbank Crannog. During 2003-2005, The Scottish Trust for Underwater Archaeology (STUA) conducted underwater and shore surveys in Loch Tay as part of the Ben Lawers Historic Landscape Project.<sup>22</sup> In addition to the author's personal involvement with the project, Dixon (2006) has published the report on the underwater findings, which are paraphrased herein. The objectives of the project were to examine human impact on Loch Tay and the further definition of how past inhabitants of the loch area interacted with and exploited the environment. Over 300 sites were examined, ranging from simple features of culturally placed stones to the remains of five crannogs dating back to the Early Iron Age. Neolithic aged oak stumps, discovered during the 2005 season yielded evidence for contemporary loch level and can be associated with Neolithic type finds from previous discoveries at Loch Tay. The survey was conducted by both SCUBA and snorkel survey along the shores of the loch, and near known Crannogs. Additional land survey was carried out by field-walking along the shores of the loch.

Two timbers, about 100m from one another, were sampled and produced radiocarbon dates calibrated to 2480 – 2280 BC, and 3540 – 3370 BC, indicating a woodland from the latter half of the Neolithic. The difference in the dates suggests the woodland existed on the edge of the loch for at least 900 years. The submerged trees indicate that water level of the loch would have been at least 5m lower than currently. Excavation of the two large stumps showed that they are of hard black heartwood, and were preserved complete with sapwood and bark in the areas in which they were protected by silt from the loch bed. Due to its soft composition the sapwood would have been eroded if these parts of the timbers had been exposed for a long period of time. There is no direct evidence of Neolithic people associated with the Neolithic aged tree stumps, however, three Neolithic stone axes, two of them decorated, were discovered less than a kilometer to the east at Balnahanaid in the

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<sup>22</sup> The Author was charged with the position of 'Field Supervisor' during the 2004 survey season of this Ben Lawers project. The Ben Lawers Historic Landscape Project was an initiative of the National Trust for Scotland with financial assistance from the Heritage Lottery Fund and Historic Scotland.

19<sup>th</sup> century. Neolithic activity in the area is also confirmed by the existence of the Neolithic axe factory site near Killin (Dixon 2006). Thus, the submerged forest provides an idea of Neolithic loch levels, and the ancient shoreline. Given this new data, it is plausible that further Neolithic artifacts and installations could be discovered in the shallows of Loch Tay.

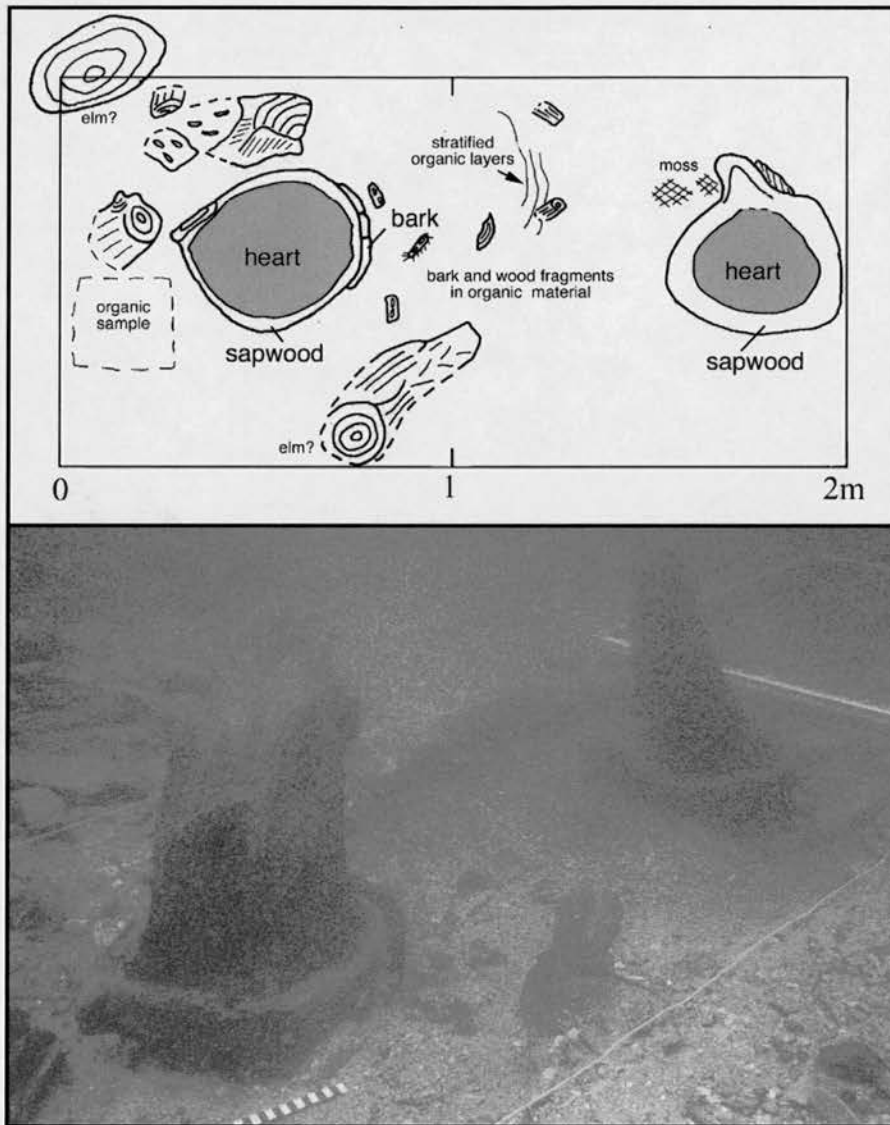


Figure 1.12 The excavation of two oak stumps from the submerged 'Neolithic Woodland' at Loch Tay (after Dixon 2006).



## **The Netherlands**

Brown Bank, the Maasvlakte in the Europoort region, and the coastal strip of the Netherlands are the three locations of the major underwater contributions from the Dutch continental shelf (Verhart 1995, 2004). Due to the Dutch coast's exposure to northerly swell, "the harsh environment of the North Sea differs significantly from the shallow waters around the Danish Isles" (Verhart 2004, 57). Finds from the Dutch coast often not discovered *in situ*, rather washed up on shore or in fishing nets. In the open water, fishermen have been dredging up Stone Age artifacts since at least as early as the 1930's (Verhart 1995). Unfortunately, many of these artifacts are sold for profit and are lost to private collections. Mostly barbed points of bone and antler have been recovered (Verhart 2004), and axes without shaft holes, adzes and picks are all present in the record (Verhart 1995). A lack of flint material has been accounted for by the fact that the artifacts are generally too small to be recovered in fishing nets (Verhart 1995), yet artifacts including flakes, blades cores and a scraper were found in a shell-fishing debris in 1999 (Verhart 2004).

Bergschenhoek, the oldest Dutch underwater site was first excavated in the 1970's. It was comprised of a peat island with a fish trap, a hearth, and planks from a dugout boat (Verhart 1995). Additionally, Hazendonk, a continuous Neolithic occupation of a river dune, dates from c.6250 BP to c.4050 BP. Here, hunting and fishing were primary means of subsistence, and agriculture made only a minor contribution to the diet. Cereals were possibly transported by the residents themselves, and domesticated animal species of cattle, pig, and sheep/goat, made up only <20% of the faunal remains (Verhart 1995).

## **'Doggerland'**

Named after the Dogger Hills which later became Dogger Island, 'Doggerland' is now entirely submerged by the North Sea. This area between continental Europe, the Danish mainland, and Great Britain has been reconstructed for its paleoenvironmental discussion, and archaeological considerations (B.J. Coles 1998).

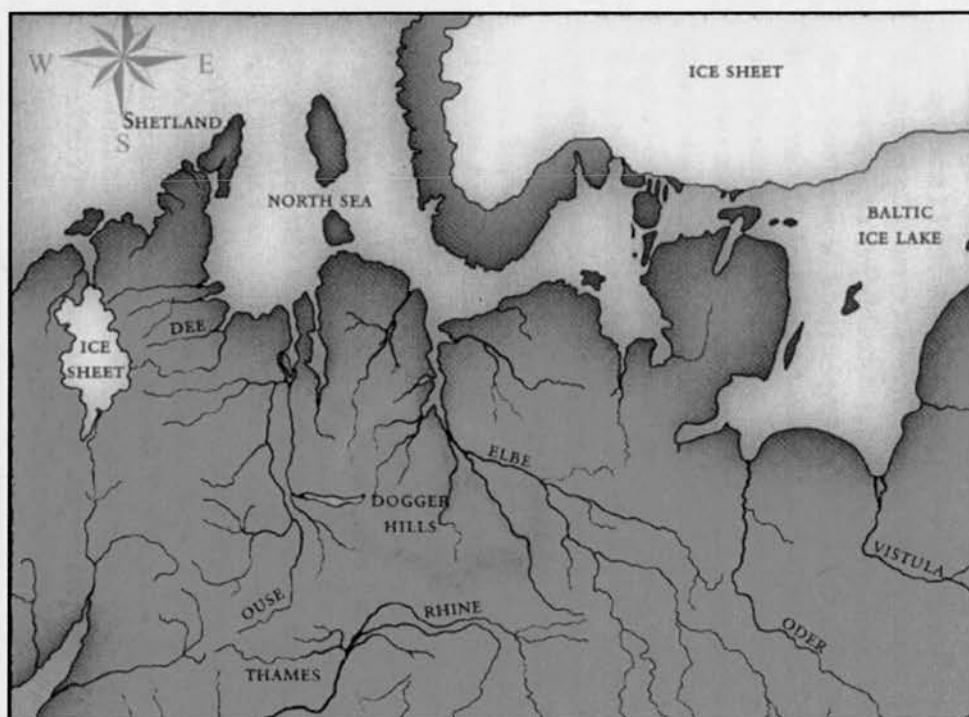


Figure 1.13 A reconstruction of northern Europe during the late glacial (as published in Andersson et al. 2004).

Much of the archaeological material from Doggerland has been surfaced through non-archaeological techniques (Flemming 2004), with the most frequent discoveries coming from dredging and fishing nets. The impact of the massive, now-submerged plain on continental European populations and environment is important to acknowledge. In particular, the people who existed on this great coastal plain would have experienced repeated transgressions, resulting in flooding from the encroaching waters, and consequent settlement displacement (B.J. Coles 1998; Fuglestedt 2003). Reconstructions of the landscape and sporadic finds tell only very little about the inhabitants of Doggerland, but the submerged landscape itself must be included in any regional discussion because it was an important part of European geography during the late Pleistocene. It is possible that future underwater archaeological and geophysical study will produce more substantial data from this submerged cultural landscape.

## Germany

Extensive research has been conducted by German underwater archaeologists and there exists a strong interest in underwater methodology.<sup>23</sup> In Germany, prehistoric underwater archaeology can be divided into two distinct categories by site type. The first are the inland lakes, which are mainly associated with the pile dwellings Neolithic and Bronze Age (Schlichtherle & Wahlster 1986; Königer 1997; Schlichtherle 1997). These lakes have yielded well- preserved sites both underwater, and in marshlands, and include a variety of classic Alpine lake sites, which are discussed in more detail below. Rescue excavations at Allensback-Strandbad, Lake Constance illustrate the benefits of underwater archaeological preservation; a flint dagger was found in a cultural layer, which was radiocarbon dated through charcoal to c.2900 BC (Schlichtherle 2003, fig. 2). The dagger has been typologically compared with examples found in northern Italy. Thus, Schlichtherle discusses transalpine cultural exchange beginning as early as 3900 BC, based on regional dagger chronology, and botanical evidence.

The second type of submerged prehistoric site in Germany discussed herein relates directly to coastal archaeology and sea level rise. Sites found along the German Baltic coast, most notably those at Wismar Bay and the Island of Rügen, provide evidence of coastal Mesolithic and Neolithic cultures (Lübke 2000, 2001). These examples will be discussed in more detail in the following chapter as they relate to the discussion surrounding southern Scandinavia and the southern Baltic region during the late Mesolithic and early Neolithic.

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<sup>23</sup> In addition to a number of German books on underwater archaeology, there are two German language periodicals devoted to underwater archaeology: *NAU (Nachrichtenblatt Arbeitskreis Unterwasserarchäologie)* which contains a variety of submerged material from multiple periods, and *Styllis: Zeitschrift für Unterwasserarchäologie*, which is focused more on shipwreck and maritime archaeology. Additionally, Schöbel (1997) has listed at least 30 museums, which contain material and exhibitions on pile dwellings alone.

## **Alpine 'lake dwellings' of central Europe**

The central European lake dwellings became famous over 150 years ago after the discovery of exposed piles at Ober Meilen, Lake Zürich, Switzerland (Keller 1854). Following this discovery, Alpine lake dwellings have been a staple in underwater archaeological discussions and the importance of these lakes to general underwater archaeology is evident by their citation and summarization in countless texts (e.g. Muckelroy 1980; Blot 1996, Delgado 1997). While a thorough investigation of archaeological sites, and evidence from the central European lake sites is outside the scope of this dissertation, a mention of underwater methodology as applied to lake sites is required of any discussion on European underwater archaeology.

Furthermore, the principles of the underwater methodology are important to this discussion since the freshwater excavation techniques provide an excellent foundation for fieldwork concerning prehistoric sites. This is due to the fact that many of these lake sites have been stratigraphically excavated both in wetland and underwater environments (Schlichtherle & Wahlster 1986; Ruoff 1997). The pile-dwellings which make up the majority of lake archaeology in Switzerland, Austria, Germany and northern Italy (Schlichtherle 1997) are typically of the late Neolithic, Chalcolithic and later prehistoric periods (Straham 1997, chronology on p. 125). Thus, selected evidence from Central European lake excavations are discussed herein to exemplify potential methodology for underwater archaeology and paleo-environmental studies where such examples may apply to coastal archaeology and prehistoric sites submerged by sea level rise.

Keller's discovery, which was made during unusually low lake levels at Lake Zürich in winter of 1853-1854, is commonly recognized as the beginning of the phenomenon of Alpine lake archaeology. Despite this, there are records of earlier reports at Nidau, Lake Bienne, Switzerland from the 15<sup>th</sup> and 18<sup>th</sup> centuries (Menotti 2001). Nevertheless, the discussion brought forth by Keller caused archaeologists throughout Europe to change the way they looked at the archaeology of lakes (Munro 1886). The history surrounding the lake-dwellings of the alpine region has revolved around the types of settlements where the Lake Zürich population lived.



The *Pfahlbauten* (pile dwelling) population, described by Keller in 1854, was thought to have lived in houses built over the lake on vertical piles. Finds from numerous other lake-dwellings were discovered after Keller's initial publication, and thus the application of a pile-dwelling culture was applied somewhat universally throughout Alpine lake sites (Menotti 2001). This was discussed and revisited during the century long debate which followed Keller's initial assertion. Eventually, the debate surrounding the *Pfahlbauproblem* appears to have concluded with the introduction of more scientific evidence (Schlichtherle 1997, Menotti 2001) and it appears that the dwellings were, in many cases, not lake-dwellings but rather *lakeside-dwellings* (fig 1.13).

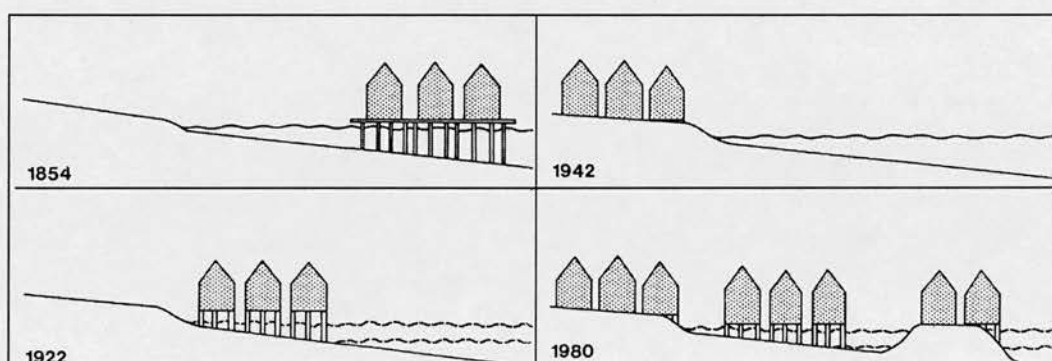


Figure 1.14 History of the *Pfahlbauproblem*: Theories over time concerning the pile-dwellings of central Europe (after Schlichtherle 1997).

“More emphasis is now placed upon chronology and patterns of occupation. This will eventually lead to a better understanding of the Alpine lake-dwelling phenomenon as a whole by clarifying the difference between the types of lacustrine settlement...” (Menotti 2001, 326).

More recently, a variety of excavation techniques and environmental sampling through underwater archaeology have provided extensive evidence from the submerged lakes of the central alpine region, and throughout Europe where lake dwellings are found (Schlichtherle 1997, distribution map on front cover; Arnold 1990, fig. 102). Underwater excavations, such as those conducted at the Neolithic and Bronze Age villages of lake Neuchâtel (Arnold 1990), Bodensee (Schlichtherle

& Wahlster 1986), and at Lake Zürich and Greifensee (Ruoff 1997) exemplify the type of archaeological results which can be achieved given proper conditions, equipment, staff, and resources, along with proper underwater methodology and excavation practice at submerged prehistoric sites (fig 1.14).

Additionally, Arnold has employed aerial photography from balloons and airplanes, which show the submerged villages scale, and the architectural patterns of the built environment (fig 1.16). This has helped define the architecture, and allows for reconstructions of these villages. Images from the site at Cortaillod Est are both dramatic, and informative (Arnold 1990, multiple figures), and illustrate a potential application for aerial imagery by underwater archaeologists.

As suggested by Menotti, recent focus on lakebed archaeology in Alpine regions of central Europe has enabled scientists to expand on the archaeological record of these submerged sites and modern emphasis has been placed on both traditional artifact recovery (macro remains) as well as botanical and environmental material (both macro and micro remains). Cereals from Neolithic early Cortaillod cultural layer, dated to approximately 3900 BC at Lake Zürich, have been micro-analyzed both genetically and morphologically and used as evidence to trace the early spread of cultivated wheat (Schlumbaum *et al.* 1998). At Lake Chalain, France, evidence of Neolithic pastoral landscapes has been suggested by the presence of flora, which survives well in areas trampled by grazing animals. This is based on results of pollen samples extracted from the submerged environment (Richard & Ségolène 1993).

Similarly, pollen and sediment analysis from Lake Annecy, France, have also been used to illustrate landscape and lake level change during the middle Holocene (Magny *et al.* 2003). This data has been used in conjunction with the cultural material recovered by underwater archaeologists and is dated by dendrochronology to 3780 BC, providing paleoenvironmental data contemporary with the archaeological material found at Lake Annecy and further defining the environmental picture.

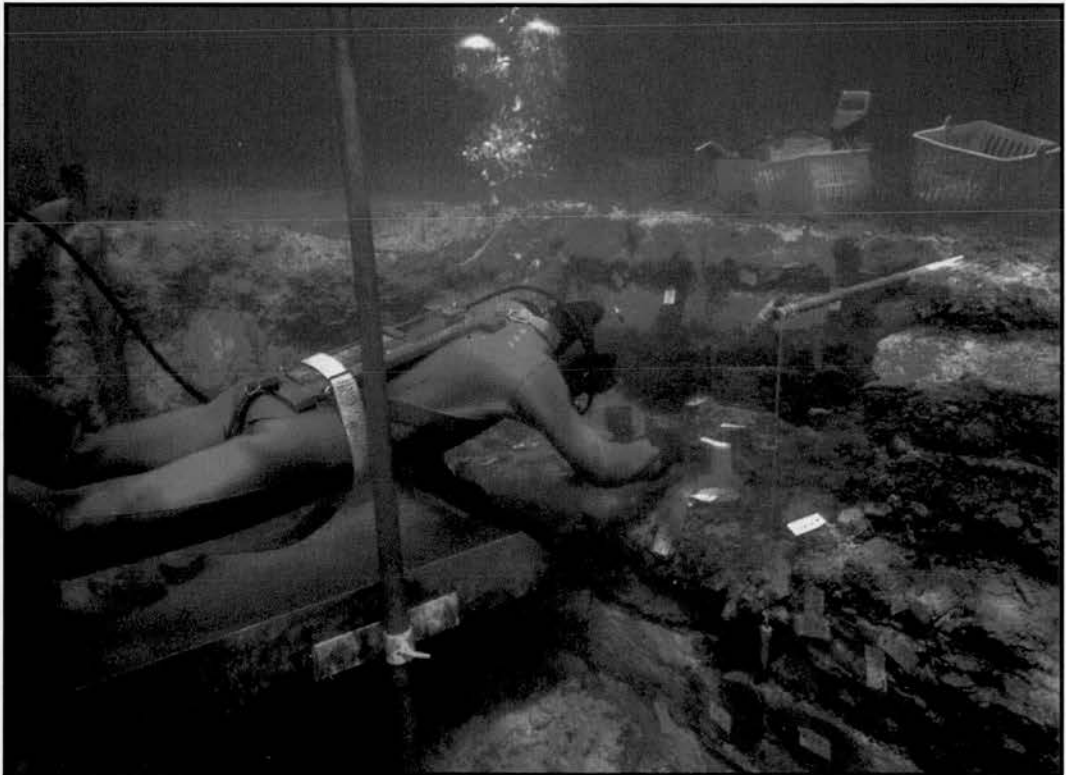


Figure 1.15 Stratigraphic excavation of an underwater late Neolithic pile-dwelling site in Lake Zürich (Ruoff 1997). Excavation methods from lakes may be applied to other submerged prehistoric sites.

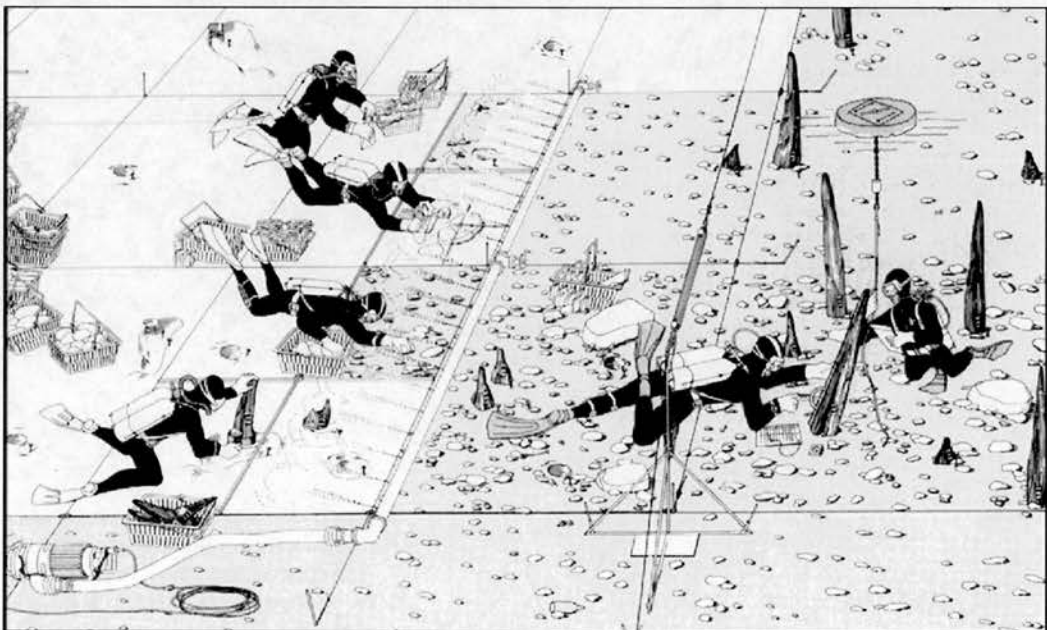


Figure 1.16 Diagram of underwater excavation technique from a pile dwelling site at Lake Neuchatel (after Arnold 1990).



Figure 1.17 Aerial Photography of an underwater pile-dwelling settlement site at Lake Neuchâtel (Arnold 1990).



Advances in underwater archaeology and its application to central European lake sites have expanded from early investigations in the 19<sup>th</sup> century to include stratigraphic underwater excavation, aerial photography, and macro as well as microbotanical sampling. The results have enabled a systematic exploration of the Pfahlbau phenomenon, established chronologies throughout central European sites, and enabled the recovery of material found in excellent conditions of preservation. The information made available through these efforts ranges from unique finds such as hafted stone tools, to large scale definition of features such as village reconstructions. Furthermore, the environmental data recovered helps associate the archaeological material within the natural setting of these submerged cultural landscapes and contributes to broad-scale debates such as the spread of domesticates in Europe.

## Italy

There is only very limited prehistoric evidence from submerged sites in Italy, mainly coming from northern Italian Lake sites (Schlichtherle 1997, inside cover map) and from La Marmotta, Lazio (Fugazola Delpino *et al.* 1993, 1995). Wooden objects from Neolithic sites in Italy are rare, and thus the Alpine sites and La Marmotta form the exceptions at which bowls, baskets, textiles, hurdles, canoes and paddles, and wooden hafting have been recovered (Malone 2003). The early Neolithic site at La Marmotta, Lazio, is now 8m deep in lake Bracciano (Lago di Bracciano), and would have existed along the lake-shore in Neolithic times (Fugazola Delpino *et al.* 1993). Positioned near the Arrone River, the inhabitants would have had direct access to the Tyrrhenian coast. The pile dwelling site was dated radiometrically ranging from 5740 BC to 5130 BC (6874±7 BP to 6189±7 BP) (Bernicchia *et al.* 2006).

La Marmotta has produced evidence which is significant to the Italian Neolithic, and includes lithics, wooden structures, and faunal remains (Fugazola Delpino *et al.* 1993, Malone 2003). Faunal remains indicate that the Neolithic people at La

Marmotta raised sheep, goat, and pig, and some cattle. Hunting was practiced and a variety of faunal material from duck, deer, fox, cat, boar, otter, hare, and fish and turtle were recovered. Floral material from the site indicate the presence of emmer, einkorn, barley, lentils, hazelnut, figs, grapes, blackberry, strawberry, flax, juniper, poppy, and bracken (Fugazola Delpino *et al.* 1993; Malone 2003). Additionally, the earliest known watercraft from Italy have come from this site in Lake Bracciano (Fugazola Delpino *et al.* 1995). This has been interpreted to imply that similar simple boats, made from reed, or logs, would have been used along the Italian coast during the early Neolithic (Farr 2006). Thus, evidence from this site can be considered an important element to the discussion of Neolithic seafaring.

Flemming (1983, 2004) has made limited reference to prehistoric material from submerged sea caves in Italy, particularly those around Cape Palinuro where Paleolithic evidence has been recorded. A recent publication sponsored by the Italian Ministry of the environment synthesizes fifty years of sea cave exploration in Italy (Cicogna *et al.* 2003). This general environmental contribution also includes a discussion on underwater archaeology and the potential for archaeological discovery in the submerged rock-shelters and caves in Italian waters. It is hardly surprising that caves in Italian waters would be considered for their potential archaeological remains given the evidence from sites such as Cosquer cave in France, and cave sites



on land throughout Europe. Future archaeological investigations of the submerged sea caves may well provide more Stone Age evidence from Italian coastal zones.

Figure 1.18 A distribution map of submerged sea caves in Italy (after Cicogna *et al.* 2003). Future archaeological investigations may yield well-preserved prehistoric material from these environments.



## **Eastern Mediterranean and Aegean**

Sites from Greece, Cyprus and Israel are discussed herein. While traditionally associated with Levantine archaeology, Israeli sites are amongst the best preserved submerged Stone Age sites in the world and are discussed herein for their contributions within the greater Mediterranean region. Greece has relatively few Stone Age sites discovered in submerged environments and Cyprus, until recently, has not been the focus of *any* fieldwork concerned with submerged Stone Age sites. Thus, original survey results from Cyprus are described and future possibilities for underwater research in Cyprus are discussed.

### **Greece**

Franchthi Cave has been studied from many perspectives, including a stratigraphic and sedimentological perspective (Farrand & Jacobsen 2000), a lithic (obsidian) perspective (Renfrew & Aspinall 1990), a paleobotanical perspective (Hansen 1991), mollusk remains (Shackleton 1980, 1988), mortuary practices (Jacobsen & Cullen 1981), and ceramics (Vitelli 1989). Additionally, Franchthi Cave has been discussed for its evidence for early maritime travel (Bass 1972; Flemming 1983), because presence of non-local obsidian in this cave has been used to discuss early trade and distribution networks (Renfrew & Aspinall 1990; Farr 2006). Given the extensive study of Franchthi, it is not surprising that underwater survey has taken place in the nearby submarine environment (Gifford 1983). Perhaps more surprising is that there have not been more comprehensive underwater efforts in the vicinity.

In 1981, sediment samples were taken from two submerged locations near Franchthi cave. Core samples were used to establish a sediment sequence in the outer part of Koiladha Bay, which separates the Franchthi headland and the island of Koronis (Gifford 1983). At the base one of the cores, a stratum with cultural material was discovered taken approximately 5.5m below the modern seabed, at a depth of 4.5m underwater. The first indication of cultural activity from this core came from this layer rich in mollusk remains, which suggested the potential presence of a shell

midden. Within the layer approximately 30 pottery fragments were recovered. The inner fragments of the ceramic material indicate a potential Neolithic fabrication (Gifford 1983), an age which seems plausible given the depth of the discovery beneath at least 2m of marine sediments and 4m to 5m underwater. Further survey and excavation in the region near Franchthi cave may produce underwater archaeological discovery based on the location of the cave itself, as well as the results from the coring conducted by Gifford.

In 1980 and 1981, excavations at Aghios Petros were conducted at this site, which is composed geographically of a small bay and island within the northern Sporadhes islands in the Aegean Sea (Flemming 1983b).<sup>24</sup> The site of Aghios Petros, which covers a space of 30m by 50m, has produced Stone Age artifacts from both the land surface and the seabed of the site's submerged environment (Efstratiou 1985). The island, or islet, measures 150m in length and 70m wide, and forms a small hill which rises from the sea. The site at Aghios Petros has been a point of interest since its original excavations in 1969 – 1971 conducted by Theochares (Efstratiou 1985). Shoreline survey produced ceramic, bone, and obsidian on the land surface during the initial phases. During the second season a team of six snorkelers were called upon to work in conjunction with the land team. Their task was to survey and examine for visible archaeological material, but also to examine submarine topography (Flemming 1983b). Evidence for any material relating the site to a harbor, or any seafaring activity was particularly sought. The site was first considered as a natural harbor in 1970, which continued to be a geomorphological theme in question throughout fieldwork (Efstratiou 1985).

The shelf between the island and the mainland is relatively flat and is found at a depth of around 5m to 5.5m. During this first season of underwater survey, no archaeological material from the known Neolithic or Bronze Age occupations on land were discovered; Byzantine pottery was present from a known shipwreck in the vicinity. Despite the snorkelers' lack of prehistoric discovery, they were able to

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<sup>24</sup> Fleming (1983) spells the site 'Aghios Petros', while Efstratiou (1985) translates the original Greek spelling to 'Aghios Petros'.



successfully identify two submerged freshwater springs, which were found by observing a change in water temperature. It was decided that underwater survey would continue, and since no SCUBA diving was conducted during the initial phase, a further examination of the seabed was deemed appropriate despite the initial lack of cultural material on the seabed (Flemming 1983b).

A closer examination of the seabed at Aghios Petros produced radically different results than the snorkel survey. Flemming recounts that 1m<sup>2</sup> test excavations were conducted by manually excavating approximately 25cm beneath the sea bed. Material from the first test excavation was placed into a bag and the underlying bedrock was cleaned with a brush. After removal of the first test excavation, the material was cleaned and sieved. Within this first test excavation many artifacts were recovered including ceramics, bones,<sup>25</sup> shells, obsidian, flint and quartz. The age of the material appears consistent with the Neolithic and Bronze Age occupations found on shore. Thus, further excavations were conducted on the seabed, yielding similar results. Faunal material, consisting mainly of mainly sheep and goat remains, and two small ceramic figurines were discovered underwater (Flemming 1983b). The site was sketched out using overlay-tracing and a photo-mosaic from the underwater environment.

Despite “the fact that the Neolithic settlement is located in the best anchorage for several tens of kilometers” (Flemming 1983b, 263), Flemming does not accept this alone as proof for the existence of a harbor. Furthermore, according to Flemming, the case for the site having been a major settlement is bolstered by the presence of freshwater spring. The presence of the Freshwater springs, however, may be questioned as it has been shown that submerged freshwater springs may not have existed in its modern location in ancient times (e.g. Č. Benac 2003). Nevertheless, Flemming speculates that the site was probably a harbor, despite a lack of evidence of marine watercraft, or related anchorages. This is based primarily on negative data and other studies which have suggested that Stone Age harbors did not employ the

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<sup>25</sup> See bone table 1 in Efstratiou 1985 pg 157 for submerged faunal material.

use of major structures (Flemming 1983b). Considering the samples of obsidian recovered (Efstratiou 1985, 171), further underwater excavation of the site may provide more information.

Finally, archaeological evidence from western Greece, at Corfu and surrounding islands of Lefkas, Dhiaph, Matraki, and Othonoi have produced evidence of human occupation during the middle and late Paleolithic (Sordinas 1983). The latter three islands, situated to the northwest of Corfu, have been described by Sordinas as Islets, and the artifacts recovered from the eroding surfaces from these locations are described as honey or chocolate colored flints that are characteristic of Paleolithic flints from the Greek mainland (Sordinas 1983). These items are found submerged near the modern coast of Corfu, which, due to erosion, has exposed the ancient lithics. A further discussion on submerged archaeology of the eastern Adriatic will also suggest that such coastal islets are indications of potential survey sites for Stone Age material in the region.

## **Israel**

The submerged environment off the coast of northern Israel has been the focus of numerous underwater archaeological studies (Raban 1983; Wreschner 1983; Galili *et al.* 1993, 1997), as well as environmental studies on sea level rise and sedimentation processes (Ronen 1983; Stanley & Galili 1996). The submerged Pre-Pottery Neolithic Village of Atlit-Yam has been studied for its archaeological contributions (Galili *et al.* 1993), as well as its greater regional significance concerning paleobotanical remains (Galili *et al.* 1997) and physical anthropological studies of Levantine populations (Eshed *et al.* 2004). From the perspective of the prehistorian with an interest in underwater methodology, the Israeli coast offers a wealth of examples and experience in practical application.

A recent proliferation of underwater archaeological discovery in Israel is partly the result of interest by archaeological divers, and partly due to changes in coastal landscape and sedimentation (Galili *et al.* 1993). Sites found in Israel have been

covered by sand for thousands of years, and are uncovered by processes of human disturbance or coastal storms (Raban 1983; Wreschner 1983; Galili *et al.* 1993). Raban (1983) credits recent quarrying of sand from beaches, and other disruptions in the natural environment of the seafloor near the Israeli coast as reasons for the exposure of ancient underwater sites. Since the coast of Israel is essentially straight, with small bays and river-mouths present, the prehistoric remains, which can survive in the region, are found at the foot of sandstone ridges, usually protected in loam and mud of the submerged basins. The Israeli coast is a high energy zone with waves arriving from over 2000 kilometers away (Flemming 1983, fig. 4), yet despite this, sites have been preserved well for millennia. Nevertheless, the coastal impact of such weather systems and the resulting fetch plays a significant role in archaeological preservation and discovery.

Volunteer divers from the undersea exploration society of Israel conducted a number of surveys in 1964. Tel Hreiz,<sup>26</sup> a Chalcolithic site at a depth of 2m to 2.6m, was discovered during this effort. The 200m long site contained rubble pavement and irregular platforms of sandstone slabs. Flint implements, pottery sherds and a hearth defined by large pebbles were all discovered at Tel Hreiz. Additionally, burned twigs and bones were found. The site was typologically dated using the lithic and ceramic remains (Raban 1983).

Hof Dado was found at 10m to 20m from shore at a depth of 1m to 2m. The site was first discovered by Galili by visual survey after winter storms in 1980 disrupted the existing seabed. Hof Dado is 30m by 15m and contains floors consisting of flat sandstone slabs, which are interpreted as habitations. The foundation of walls surrounding the floors are made of rubble and there are at least a half dozen of the structures which contain stone hearths in total. Small lithic remains such as flakes and chisels typologically characteristic of late Neolithic and Chalcolithic are represented (Raban 1983).

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<sup>26</sup> Raban (1983) has spelled the site as *Tel Harez*, while Galili *et al.* (1997) write *Tel Hreiz*.

## Kfar Samir

Kfar Samir was found 300m offshore at 5.4m depth. The dark loam exposed in 1978 produced carbonized tree roots and trunks as well as a 2.3m stone circle which surrounded one of the Oak trees (*Quercus ithaburensis*). The site was discovered through visual survey, and was originally dated radiometrically to 4560 BC ( $5700\pm140$  BP) (Raban 1983). The most important aspect of the Kfar Samir site, is its contribution to the discussion of the first evidence of olive oil in the Mediterranean (Galili *et al.* 1997). *Olea europaea* L., Wild Olive, is widely found throughout the Mediterranean, and olive oil production had previously been thought to have begun later and further east of the submerged Neolithic sites of Israel. Four late Neolithic sites of the Wadi Rabah and Lodian cultural phases have yielded evidence for olive oil production: Kfar Samir, Kfar Galim, Megadim and Tel Hreiz (fig. 1.20).

At Kfar Samir, storms spanning the years of 1993-1994 removed over a meter of sand resulting in the exposure of part of Kfar Samir which was previously unknown. Two types of olive installations have been observed at Kfar Samir, including olive stones and pulp found in pits, interpreted as ground olive waste (Galili *et al.* 1997). At this site, nearly three-quarters of the olive stones are crushed, indicating processing of the fruit. The preserved olive stones were found in stiff clay, protected for millennia by overlying sand. Radiocarbon dates from the olive stones and pulp were dated and indicate a span from 5510 BC ( $6500\pm70$  BP) (Raban 1983) to 4460 BC ( $5630\pm55$  BP, RT-1929a) (Galili *et al.* 1997). Human dwellings have not been associated with this site, which suggests that this was a special industrial zone where olive oil production took place (Galili *et al.* 1997). The people who used the now submerged installations, perhaps lived in settlements east of the shore, on the adjacent coastal ridges and slopes.



## Newe Yam

In January of 1968, a heavy storm exposed the submerged Neolithic village of Newe Yam at a maximum depth of 5m, and 250m offshore (Wreschner 1983). The large site is located on the western side of the Kurkur ridge. The sea flooded the nearby basin and there would have been an estuary from the Me'arot river which was eventually transgressed (Raban 1983). The site was excavated and the artifact collection included lithics, bone, stone mortars, bowls, pottery and faunal remains (Wreschner 1983). In total 936 flint implements and 18 bone tools were recovered. Five obsidian fragments were also discovered and are suggested to have originated in Anatolia (Raban 1983). Only 10 of the flint tools appear to have been rolled or abraded, indicating a protected environment under sediments and sand. This is reinforced by the presence of only 12 patinated lithics, which suggest only minimal exposure to surface. Half of the ceramics present show sharp breakage fractures and are not rolled (Wreschner 1983), indicating a relatively fast transgression and a protected environment.

Based on morphology and the additional presence of bone tools the lithic assemblages appear to have been used for hide working at Newe Yam. This has been interpreted as evidence of a pastoral subsistence based on *Capra*, present in the faunal remains. Thirteen fragments of basalt mortars are present, and have been suggested as an indicator of social networking and trade, since the nearest basalt source was found 30 km inland (Wreschner 1983). Foundations of structures, which were partly visible in the surf, are 7m to 9m long and 2m to 3m wide. Structures such as silos, fireplaces and courtyards as well as the presence of sickle blades are cited as evidence for agricultural practice and appear to have occurred in two levels of occupation (Raban 1983). The site has been radiocarbon dated to 2990 BC ( $4360 \pm 395$  BP) based on a charcoal sample (Wreschner 1983).

## Atlit-Yam

Excavations at Atlit-Yam were begun by Galili in 1987, and the site is an important contribution to Israeli archaeology (Wolff 1998), and the greater record of Levantine prehistory (Eshed 2004). Atlit-Yam is the largest, and deepest settlement found submerged off the coast of Israel and was discovered 300m offshore, at depths between 8m and 12m (Galili *et al.* 1993). The 60,000 m<sup>2</sup> site has produced Pre-Pottery Neolithic evidence in the form of human dwellings, lithic tools, flora and faunal remains, and evidence of fishing. Since prehistoric sites are rarely found *in situ* underwater (Flemming 1983; Galili *et al.* 1993), this site is an outstanding example of good preservation and underwater excavation of a transitional early Neolithic site.

Fieldwork at Atlit-Yam took place mainly during the month of September, when weather and sea state are at its best for working conditions. Nevertheless, surveys after storms during winter months were also conducted to investigate the displacement of sand and sediments, which might cover archaeological material (Galili *et al.* 1993). The site was mapped out methodically by marking the identified structures with iron rods, plastic tags and surface marker buoys. The rods were long enough to ensure re-discovery of the features even after sedimentation during storms. Excavations were carried out using an underwater dredge operated from a small boat (fig. 1.18). The excavation team of two divers underwater worked in tandem with one excavator responsible for the suction area of the apparatus, the other responsible for the waste end. The site was excavated in 10cm artificial spits, whereby both the archaeological and waste material were removed, tagged and sieved on the surface. Additionally, core sampling was conducted for the collection of microbotanical remains (Galili *et al.* 1993).

Several rectangular structures were recorded at Atlit-Yam. Most walls were made with two rows of stone and laid horizontally. Structure 15, however, is of particular interest as the wall, 20cm in length and 1m to 2m thick, was made of baked clay bricks and is positioned near the ancient location of the river Oren. It is suggested

that the purpose of this structure was to prevent flooding along the riverbank (Galili *et al.* 1993). Hearths between 50cm and 140cm in diameter were discovered near or inside the structures. They are generally built of stone and contain charcoal, bone, baked clay and in some cases of plaster. Excavations took place in structures 9, 13, 35, and structure 11, a water-well.

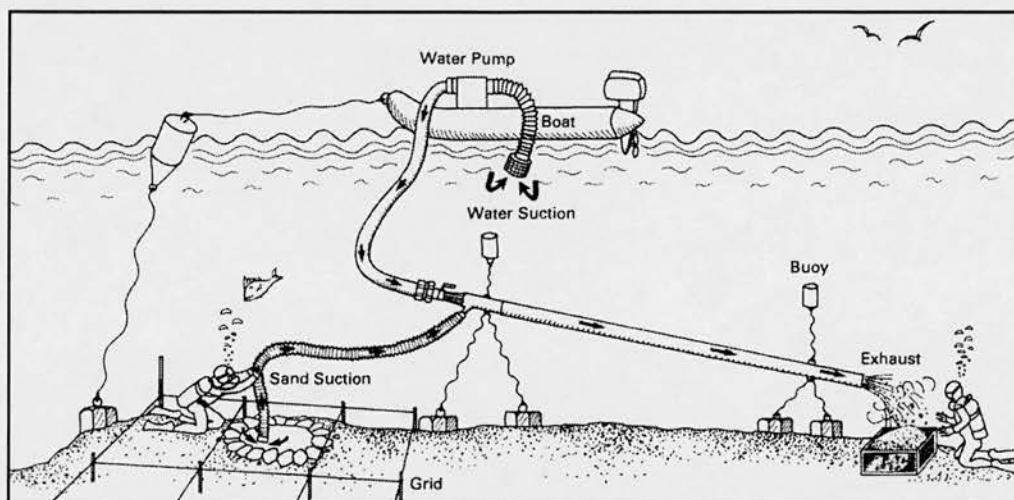


Figure 1.19 A diagram of underwater archaeological excavation using a dredge system at Atlit-Yam (after Galili *et al.* 1993).

In structure 35a, a flint concentration was excavated. The assemblage at the structure consists of 8755 flint artifacts, wherein flakes outnumber blades by over two to one. The assemblage contains 25 cores, of which half are bipolar and the rest uniplatform or broken. Thus, structure 35a has been labeled a workshop as it exhibits intensive lithic production. Surface scatter collection was conducted throughout the site through visual observation and surface sampling by divers. A total of 155 tools were studied, half of which were discovered through surface collection. These discoveries included 43 arrowheads, 31 sickle blades were discovered along with 4 spearheads and a few bifaces and denticulates which appear in low frequency. There are also limited examples of scrapers and burins, as well as flaked knives and blades (Galili *et al.* 1993).

Structure 11 represents a water well marked by large stones composing the walls of the well (fig. 1.18). The circular feature measures 1.5m diameter and was excavated

to a depth of 5.5m below the paleosol. Finds from the well, which appears to have become a refuse pit, include thermally fractured limestone pebbles, animal bones, stone and bone tools, waterlogged plant remains and a few fragment of human bones (Galili *et al.* 1993). The evidence from the well, which has been discussed for its paleoenvironmental contributions (Galili & Nir 1993), also shows sediment dispersal in the region as discussed by Stanley & Galili (1996). While sedimentation from the Nile delta in the southeast Mediterranean has impacted modern seabeds in Israel as far north as the Carmel coast, it appears that during the habitation period at Atlit-Yam, sediments were mainly local. Evidence from the paleoenvironmental data show that the Nile Delta did not form until some 500 years after the occupation at Atlit-Yam and it appears that the modern patterns of sedimentation and North-South sea currents (Stanley & Galili 1996) differ from those during the Pre-Pottery Neolithic occupation.

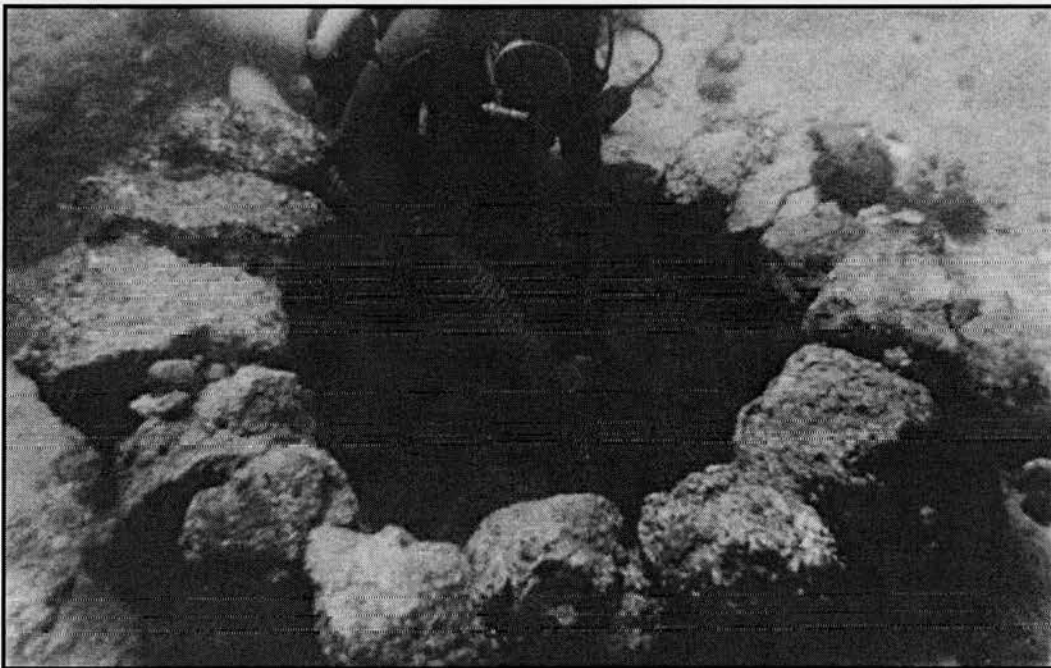


Figure 1.20 Structure 11 at Atlit-Yam. The entrance to the submerged water well as it was excavated with a flexible-hosed water dredge (Galili *et al.* 1993).

Pollen samples were taken at two locations at Atlit-Yam for environmental analysis. Additionally, charcoal found in hearths show that the PPN occupants at Atlit-Yam



used Oak (*Quercus calliprinos*) and (*Pistacia palaestina*) for firewood (Galili *et al.* 1993). This is not surprising since these are the two most dominant species of tree in the region during this time (Lipschitz & Biger 1990). Also found on site are waterlogged remains of olive (*Olea europaea*), carob (*Ceratonia siliqua*), aphylla pine (*Tamarix aphylla*) and date palm (*Phoenix dactylifera*) as well as carbonized and waterlogged seeds of fig (*Ficus carica*), grape vine (*Vitis vinifera*), carob, almond (*Amygdalus communis*), and lentil (*Lenus orientalis*, *Lens ervoides*, or *L. esculenta*) (Galili *et al.* 1993). Unlike the younger submerged site Kfar Samir, no olive stones were found at Atlit-Yam (Galili *et al.* 1997).

There are 322 identifiable faunal remains present in the form of bone, while 177 bone fragments remain unidentified. Goat and cattle make up the vast majority of the remains at 45% and 43% respectively. There is also presence of pig (9%) and Gazelle (3%). Galili *et al.* have suggested that the animals found at Atlit-Yam are of a wild variety, rather than domesticates. Nevertheless, “incipient domestication, a phase preceding full scale domestication with selective breeding” has been implied based on animal type and the physical paleoenvironment (Galili *et al.* 1993, 152). Hunting was not the only source of protein at Atlit-Yam. Situated near the coast, the sea would have been ideal for fishing indicated through a variety of evidence. In all, 228 fish bones were discovered and identified from two species. The majority (92%) are of gray triggerfish (*Balistes carolinensis*). The evidence of triggerfish suggests an offshore fishing industry, according to Galili *et al.*, as the species is not typically present above 10m depth. The remaining 18 bones found were from a type of grouper (*Epinephelus aeneus*).

Skeletal evidence from the population has also been used to suggest a seafaring culture. In 1993 there were 15 human skeletons found at Atlit-Yam (Galili *et al.* 1993), and by 2005 25 skeletons had been recovered (Eshed *et al.* 2004). Health of the population was poor, and in all cases, varied degrees of hypoplasia were discovered in the bones of the 15 individuals (Galili *et al.* 1993). Burials are located near the dwellings and were mostly composed of single graves with skulls intact. Some disarticulated bones were also recovered, which has been interpreted as

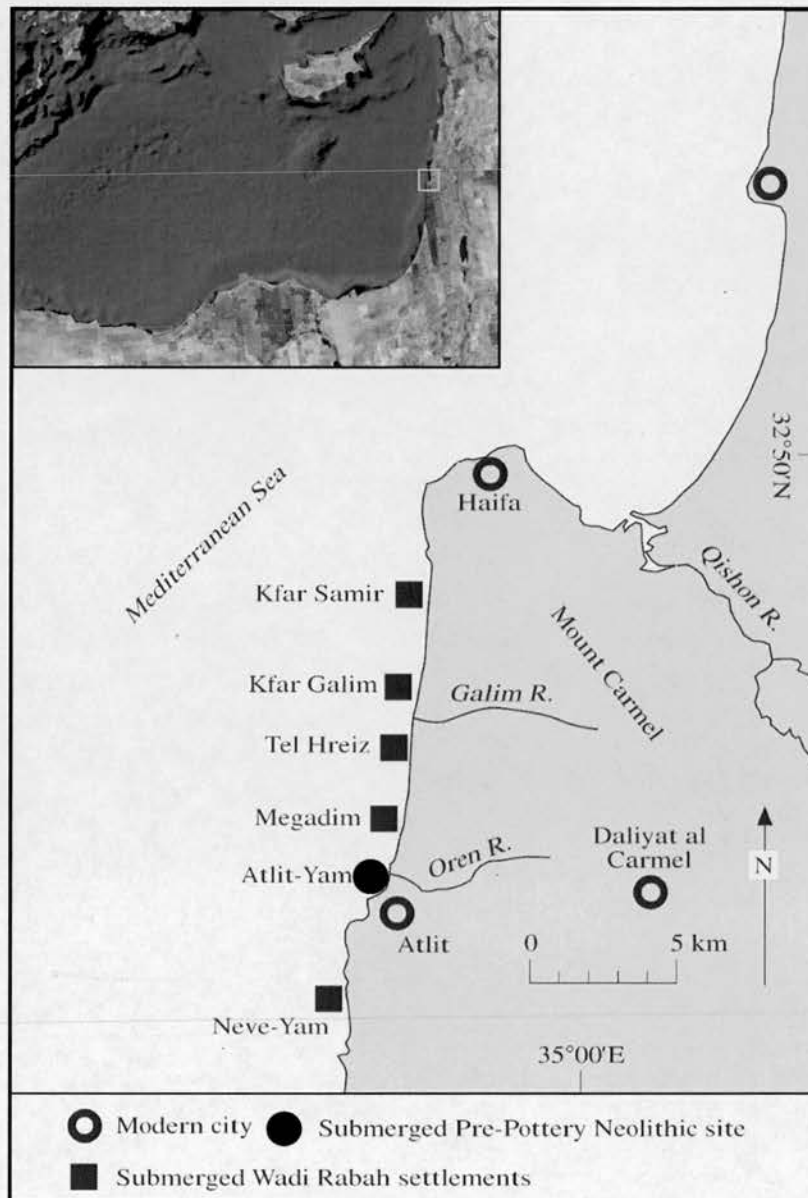


Figure 1.21 Map of the Israeli Carmel Coast and submerged Stone Age sites (after Galili *et al.* 1997).

secondary burial (Galili *et al.* 1993). In a study comparing early Neolithic inhabitants of the Levant with pre-Neolithic Natufian Hunter-Gatherers, Eshed *et al.* (2004) used over 50% of the Neolithic samples from Atlit Yam. Of the 25 individuals from Atlit-Yam, all but one were identified by sex. The results of this study suggest that the males from Atlit-Yam over-utilized their muscles in their

upper limbs based on examining the muscle and ligament attachments. This is not evident in other inland Neolithic Levantine populations and is thus interpreted as the results of paddling, thus indicating seafaring activities (Eshed *et al.* 2004). Additionally, the dental wear patterns on the population's teeth are suggested to have possibly been caused by gripping rope or leather straps, considered to be more evidence of "fishing activity" (Galili *et al.* 1993, 52). It must be acknowledged however that this is speculative, as there is no direct evidence to support this theory relating dental wear to fishing activity.

Atlit-Yam is one of the most informative sites known from the Pre-Pottery Neolithic period in the Levant and the contribution of underwater methodology must not be overlooked. It is a key site concerning early seafaring activity as indicated through evidence of fishing and indirect skeletal evidence associated with boating. Thus, Atlit-Yam may be an important eastern Mediterranean site for the discussion of westward Neolithic migration (Galili *et al.* 1993).

### **1.6 Original Fieldwork: Potential Pre-Neolithic Discovery in Cyprus**

The aceramic Neolithic began in Cyprus around 8200 BC. This is based on radiocarbon dates from the sites at Shillourokambos, Mylouthkia, Kalavasos-Tenta and Akanthou (Ammerman & Noller 2005). These settlements include finds providing evidence of cultivated plants (wheat and barley) and grazing animals (sheep, cattle and pigs) associated with the new subsistence economy. However the question of what took place on Cyprus during the time before the Neolithic remains. Ammerman & Noller have suggested a series of questions and possibilities among them: Seasonal visits by hunter-gatherers who arrived by boat from the nearby coasts of Syria and Anatolia. How long would such an expedition have lasted? Could foragers have already settled on Cyprus permanently? How old is the earliest evidence for hunting and gathering on Cyprus? More reliable <sup>14</sup>C dates from Aetokremnos, done on charcoal samples, would appear to indicate an age of at least 9500 BC (Ammerman & Noller 2005).

Pre-Neolithic flint artifacts appear to show evidence of the earliest occupation of Cyprus (Ammerman & Noller 2005). It is likely that that portions of these coastal sites may exist underwater; a result of submergence during the early Holocene. Although no previous fieldwork specifically designed to investigate submerged Stone Age sites and material has been conducted in Cyprus, recent studies by Howitt-Marshall and Leidwanger have focused on a variety of underwater survey of sites ranging from Bronze Age anchorages to recent shipwrecks. During one such survey near Dreamer's bay of the Akrotiri peninsula, a single culturally worked flint was discovered (Howitt-Marshall, pers. com.).<sup>27</sup>

A trip to western Cyprus was conducted by the author in June 2006, to assess the archaeological potential of the submerged environment in the immediate vicinity of the pre-Neolithic Aspros site (fig. 1.21). Sea state, logistical considerations, and conversations with local dive professionals were all a part of this regional familiarization process and feasibility study. In particular, the following elements were evaluated and observed for their impact on underwater archaeological potential: seabed composition, sedimentation, visibility, currents, surf and presence of archaeological material underwater. Results from this study will help determine methodology for the proposed future underwater survey of the Cypriot coast, which will focus on submerged material from the late Pleistocene and early Holocene. The sea level at c.12,000 BP would have been approximately 70m below sea level based on the most current measurements and traditional sea-level curves (Fairbanks 1989; Lambeck *et al.* 2004).

The site at Aspros is located North of Paphos, on the west coast of Cyprus, and found on an Aeolianite surface (fig. 1.21). Aeolianite, which is a porous sandstone material of cemented dune has been described as "Paleo-dune ramps" (Ammerman & Noller 2005, 538). The small point slopes into the sea at the end of a dry river mouth. The aeolianite surface on the South side of the headland has broken off in

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<sup>27</sup> Duncan Howitt-Marshall is a doctoral candidate at Cambridge University and was a participant in the POCA 2006 conference hosted by Edinburgh University. See appendix for further information concerning this isolated find.



large blocks, which vary in size and are partially submerged in the small bay. In the bay the underwater environment is made up of these aeolianite blocks while large cracks forms crevasses, and depressions with white underlying rock is exposed in some areas. To the immediate West of the headland, in the shallows, the large blocks of aeolianite continue around to the tip of the point. On the northern side of the point the aeolianite slopes more gradually into the sea whereby the shallows near the shore environment contains less vertical surfaces than the southern side. Large sections of broken aeolianite do exist near shore north of the point.

By merely two SCUBA dives, and two sessions of snorkeling around the headland near Aspros, it was concluded that the area is suitable for further underwater archaeological survey and test excavations. A location sheltered by a submerged natural breakwater near the point was the focus of a specific survey and ten small lithic samples were taken from this location (fig. 1.21). From this collection, it can be concluded that small pieces of broken flint are found on the seabed in such sheltered environments. At least one of these flint pieces appears to be conchoidally fractured (McCartney, pers. com.),<sup>28</sup> which likely indicates cultural production. Of the ten flint samples surfaced from this sheltered area, four pieces were identified as potentially cultural. Regardless of the character of the flint, it was established that such sheltered areas in the underwater environment allow for the protection of worked flint rather than destroying lithic material.

Future underwater fieldwork at Aspros would require a team of archaeological divers, and necessary equipment. Locations sheltered from the westerly swell are perhaps the key to discovering archaeological material through future underwater fieldwork at Aspros. At this stage of the research, input from a coastal geologist or geomorphology specialist would be appropriate to assess the physical properties of the submerged environment. A more detailed understanding of the erosion and formation of the headland would provide a more specific idea of where potential archaeological finds may be discovered *in situ* or if they would have been displaced

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<sup>28</sup> Carole McCartney is a lithics specialist who has lived and worked in Cyprus for two decades.

and transported to lower energy zones. Such a geological and geophysical assessment could be conducted either by SCUBA diving or snorkeling during appropriate weather and sea conditions.

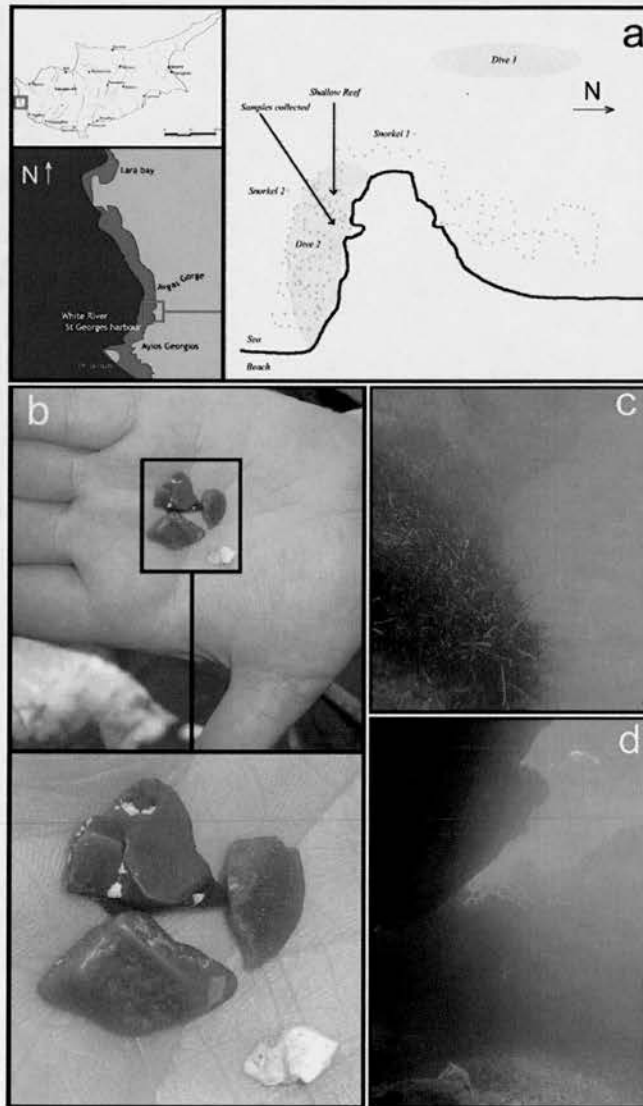


Figure 1.22 a) a sketch map of the Aspros site with areas covered during the initial survey. b) lithic samples collected from the sheltered area south of the point c) the end of the aeolianite, the submerged paleosol d) a depressed area in the aeolianite is suitable for sampling, providing a sheltered environment.

The most effective method for sampling would be test excavations using an underwater dredge (fig.1.2, 1.18). Material should be excavated in controlled areas, and brought to the surface for examination. Lithic material from the underwater environment may appear different from corresponding artifacts on land and a lithic specialist with regional knowledge would be required. Rounding and polishing of

flakes and cores as a result of polishing is likely at Aspros. Submerged lithic artifacts may also exhibit varied patina when recovered underwater, depending on the amount of surface exposure; it is possible that they may show no, or limited signs of patination (e.g. Galili *et al.* 1993), or that the patination occurs, however differently from that on land. In some cases patination found from underwater material can differ from that found locally on shore, including changes or differences in color of the patina (Fischer, pers. com.)

Additionally, it is likely that there are other areas along the Cypriot coast which contain submerged Stone Age evidence and better conditions for their preservation. There is undoubtedly a potential for future underwater study in Cyprus with more ideal locations found in low-energy environment; the east coast may provide a number of possible locations. The reduced fetch from the open sea will greatly improve conditions and recently, new sites, similar to that of Aspros have been discovered on coastal Aeolianite surfaces (Ammerman, pers. com.).

### **1.7 Conclusion: Underwater Archaeology and Stone Age Sites in Europe**

Underwater archaeology has undergone a half century of advancement and definition. The need for a continued integration of underwater methods within prehistoric archaeology is clear. This is especially true for coastal archaeology, since global sea level data and regional tectonic measurements show that much of the shallow waters found in the nearshore environments of European seas are areas of previous cultural activity. There is a great opportunity for future discovery along submerged European coastlines and underwater research in the Mediterranean. The Aegean and Adriatic seas are also particularly interesting for future study of submerged Stone Age sites (Flemming 2004).

Over the past half century, evidence from sites throughout Europe have begun to demonstrate that underwater archaeological methods can provide data which is not available on land and is thus important within the greater field of archaeology. This will be further demonstrated in the following chapter devoted to sites from southern

Scandinavia, but is also seen in material found throughout southern Europe, and in particular from the submerged sites in Israel. Sites such as Aghios Petros, Greece also clearly show that archaeological sites do not simply end at present-day shores, and that a modern prehistoric archaeology should not limit a survey area to the land's end. This attitude is slowly changing, as evidenced by Flemming's involvement on Aghios Petros in the early 1980's, and by Ammerman's research design at Aspros and other pre-Neolithic sites in Cyprus, which now include underwater fieldwork.

With the exception of chance finds from dredges and from exposed conditions due to lower sea/lake levels, all of the examples herein have been discovered by underwater archaeological survey and further defined through underwater archaeological excavation. This includes sites where archaeological material was first discovered accidentally, offering clues which were investigated by underwater archaeologists. Specific efforts for prehistoric underwater site discovery have also been successful in many parts of Europe, ranging from the exploration of caves to observing changes of sediments following severe weather. Finally, predictive modeling has been applied by underwater archaeologists in the search for submerged prehistoric sites; a survey strategy from southern Scandinavia is discussed in the following chapter.



## **Chapter 2**

### **The Mesolithic and the Neolithization of Southern Scandinavia and the Contributions of Underwater Archaeology**

## Introduction

The submerged Mesolithic and Neolithic contributions from southern Scandinavia can be considered amongst the most informative archaeological material in all of European prehistory.<sup>29</sup> This is due in part to the fact that there are more archaeologists, and more archaeological material available in Scandinavia than anywhere else in the world (Price 1991; Rowley-Conwy 1995). Since southern Scandinavian sites provide a large proportion of the material known from the Mesolithic and early Neolithic of northern Europe (Larsson 1990; Karsten 2004), the underwater archaeological methods, sites, and finds are important not only in a Scandinavian context, but within the larger scope of European prehistory. Given that southern Scandinavia has an importance to the European Mesolithic “disproportionate to its geographical extent” (Larsson 1990, 257), it follows that the underwater sites from this period, which are informative to the Scandinavian archaeological record, are indeed valuable to prehistoric European archaeology.

The Mesolithic and early Neolithic of southern Scandinavia have been studied in great detail and recently summarized in a variety of texts (Larsson 1990; Price 1991; Thorpe 1996; Fischer and Kristiansen 2002; Anderson *et al.* 2004).<sup>30</sup> Temporal and typological chronologies, environmental change, and an overview of the Mesolithic and early Neolithic cultural groups of Denmark and southern Sweden are briefly synthesized herein to provide a framework for the discussion concerning submerged archaeological sites, informative finds, and underwater methodology. “We must remember that as much as two thirds of the former land area was submerged in the Early Mesolithic – a process which must have influenced the structure of coastal settlement” (Larsson 2002, 278). Given such conditions, underwater archaeologists

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<sup>29</sup> The region, for the purposes of this archaeological discussion includes mainland Denmark (Jutland), the eastern Danish islands (including Zealand, Funen, and Lolland), the southern tip of Sweden, Scania and also includes the Northern most region of the German Baltic coast (Introduction, fig. 2).

<sup>30</sup> Price (1991) has written a summary on *The Mesolithic of Northern Europe*. Larsson (1990) has published an overview specific to *The Mesolithic of Southern Scandinavia*. Fischer and Kristiansen (2002) edited a series of essays concerning *The Neolithization of Denmark: 150 years of debate*. Andersson *et al.* (2004) have compiled an overview of *Stone Age Scania*.

have been investigating submerged environments for three decades in southern Scandinavia and underwater sites began to impact the archaeological record concerning the Mesolithic and Neolithization in the 1980's (S.H. Andersen 1985; 1987; Grøn 1991; 1995; Fischer 1993; 1995; Sørensen 1996).

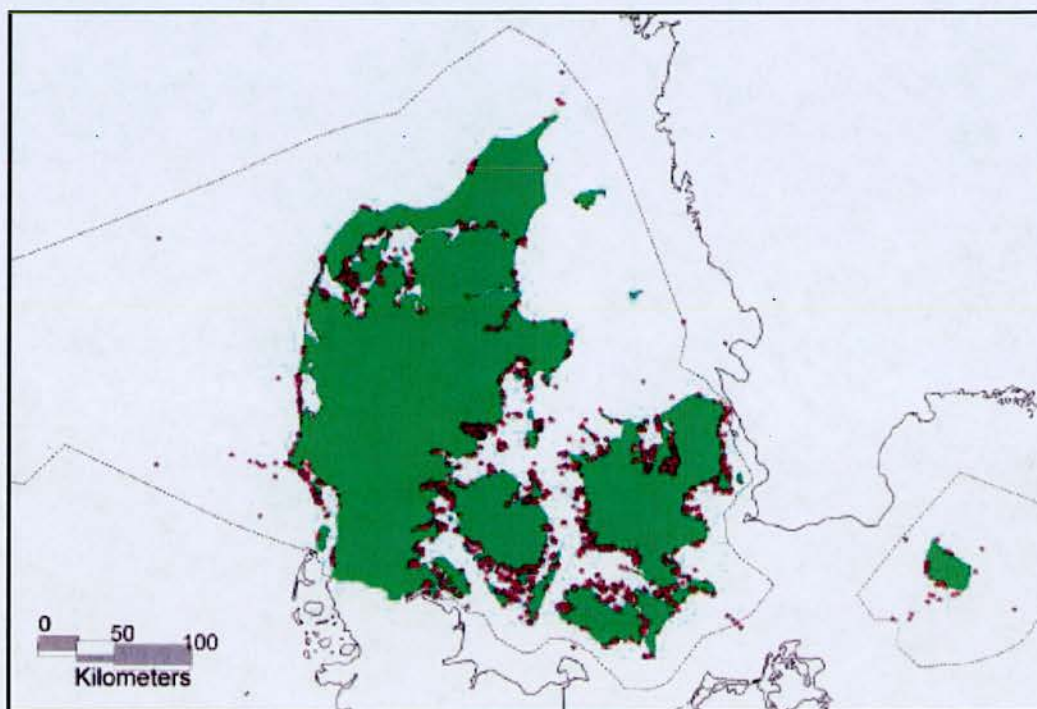


Figure 2.1 Distribution of over 2300 submerged prehistoric archaeological sites (shown in red) from Danish waters (after Fischer 2004).

## 2.1 Environment: Landscape Evolution and Sea Level Rise

Late and post-glacial climate and landscape have been a focus of Quaternary geologists and archaeologists in the Baltic region for over a century (Björck 1995; Fischer & Kristiansen 2002). Even prior to the 1920's, attempts to reconstruct the Baltic region were created to express late and post-glacial landscape evolution (Antevs 1922, fig. 1), which illustrates the rich history of scientific interest in the region. Discussions related to the climate and environment of southern Scandinavia during the late Pleistocene and early Holocene include, geological composition of landscape, topographic change, temperature fluctuations, eustatic activity and regional sea level change, isostasy and hydrology (Björck 1995). All of these variables have had an effect on the landscape of southern Scandinavia, and therefore

impacted the human populations inhabiting the region during times of rapid change (Larsson 1990; Price 1991; Fischer 1995).

Southern Scandinavia consists of lowland, undulating topography. During the Weichselian glaciation, all but the south west part of Jutland was covered by glacial ice (Larsson 1990) and as a result, the region is geologically composed of glacial deposits of clay, sand and gravel with some local variation (Andersen 2002).<sup>31</sup> North Jutland is a variation of sand and clay, while in eastern Denmark layers of fluvial-glacial sand and calcareous clay cover Tertiary deposits and Cretaceous chalk and limestone bedrock (Frederiksen 1997; Bennike *et al.* 1998).

Age	Epoch	Years BC	Depositional environment
Post-glacial	Atlantic	7000	Sea
	Boreal		Rivers, lakes and mires
	Preboreal		Temperate forest
Late glacial	Younger Dryas	9500	Lakes and rivers
	Allerød		Tundra
	Bølling		Lakes and mires
Glacial	Weichsel	12,800	Open forest
			Melt water lakes and rivers
			Arctic tundra
			Glacier

Figure 2.2 Climate and Landscape from 13,000 – 6,000 BC (after Mathiassen 1997)

Western Jutland enjoys what can be considered a maritime climate, while the central and eastern areas of southern Scandinavia are a combination of both maritime and continental climate (Larsson 1990). Larsson (1990, 275) states that “the climate in the Early Mesolithic must have been much more continental than in later prehistoric times” and that prevailing winds during the Mesolithic would have likely been easterly or southerly with half the rainfall of modern times. However, given the

<sup>31</sup> S. Andersen is here in referred to as (Andersen 2002) as republished in Fischer & Kristiansen eds. (2002), despite having been originally printed in Danish in the early 20<sup>th</sup> century.



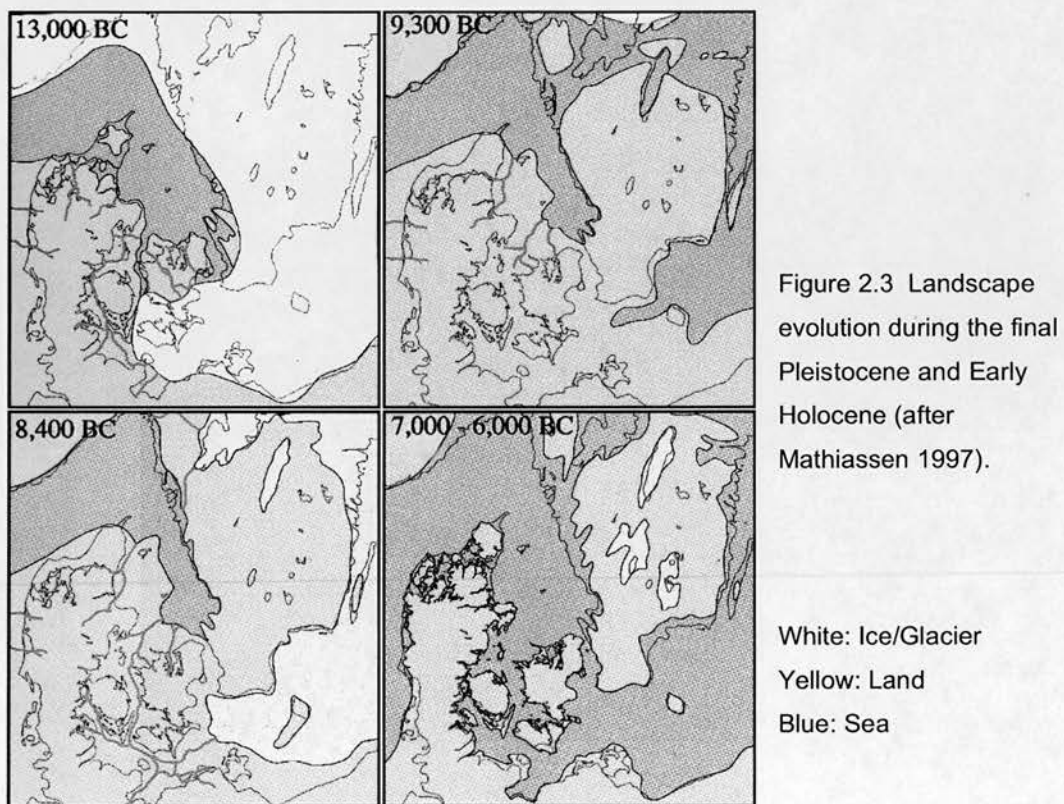
dynamics of the rapidly changing environment, more precise environmental data from local areas (e.g. Christensen *et al.* 1997; Bennike *et al.* 1998) and specific phases of physical change (e.g. Jensen *et al.* 1999) are necessary to discuss the environmental impact on human populations living at a particular time, in a specific location.

Throughout the Late Weichselian glacial period and the early Holocene, the development of the Baltic Sea went through multiple stages of transition (Björck 1995; Christensen *et al.* 1997). Climatic indicators used to study the physical changes of the late and post-glacial include seismic records, pollen data, macrofossil analysis and the presence of microorganisms, which have been used to distinguish freshwater deposits from brackish deposits (Bennike *et al.* 1998, 2004). Such evidence has shown the presence of ancient rivers and lakes beneath the modern Baltic seafloor, and allowed for detailed reconstructions of local paleoenvironments. AMS radiocarbon sequences from rapid early Holocene depositions have been used to define the warming event in the Storebælt during c.8700 – 8300 BC based on evidence of *Leptocerus tineiformis* (Wiberg-Larsen *et al.* 2001), which suggest that temperatures in summer months would have been similar to those of modern times. Beetle (*coleopteran*) assemblages throughout northern Europe have been used to show climatic change on a larger scale, but also to illustrate how temperature change can vary between locations (Coope *et al.* 1998) during extended periods of climatic change. Furthermore, evidence from wood, peat (fresh and brackish water), mud (freshwater, brackish and marine) and shells have been used to help establish the chronology of changing sea level in the Storebælt (Christensen *et al.* 1997).

Björck (1995) presents a model reviewing the development of the Baltic Sea, through its phases as the Baltic Ice Lake, Yoldia Sea, and Ancylus Lake. During the period c.13,000 – 8,000 BP, the Baltic sea was affected by isostatic uplift, glacial melting, and the resulting damming process, which created isolated lakes, separated by land from the North Sea. This occurred at least three times, from c.12,000 – 11,200 BP, from c.10,800 – 10,300 BP and from c.9500 – 9200 BP. The lakes created would have been noticeably higher than sea level, and when transgression ensued, the resulting drainage would have quickly influenced coastlines, and the

contemporary populations. The Baltic Ice lake, c.13,000 – 10,300 BP, Yoldia Sea c.10,300 – 9500, and Ancylus Lake c.9500 – 8000 BP all predated the eventual creation of the Baltic sea (Björck 1995).

Reconstructions of landscapes are possible through both modeling and seismic profiling (Mathiassen 1997). Such sonar activity includes scanning the sea bed and penetrating the surface of the sea's floor with acoustic waves. Types of deposits are interpreted and boundaries identified, making geological mapping possible (Mathiassen 1997, fig. 2).



Based on available data of the region, some generalizations have been accepted by archaeologists concerning the paleoenvironment of southern Scandinavia: The Late Weichselian ice began its retreat from eastern Denmark by c.16,000 BP as the temperature increased from 10°C at c.16,000 BP, to 18°C at c.13,000 BP, and continental glacial ice had disappeared from northern Europe by c.8500 BP (Price 1991). The sea transgressions are complex due to extensive isostatic activity, and

ongoing isostatic and eustatic activity, resulting in shore displacement, and rebounding land masses (Larsson 1990). While the southern half of the region was subsiding during the early Holocene, the tilt line ran diagonally from northwest to southeast through Denmark (fig. 2.4). In the southwest of southern Scandinavia, land has subsided up to 9m since the late Mesolithic. Isostasy resulted in a rebound of as much as 8m to 10m per century in southern Scandinavia and was most significant in the northern part of southern Scandinavia, where rebound is still taking place. In the south, the lesser degree of isostatic activity has ceased (Larsson 1990).

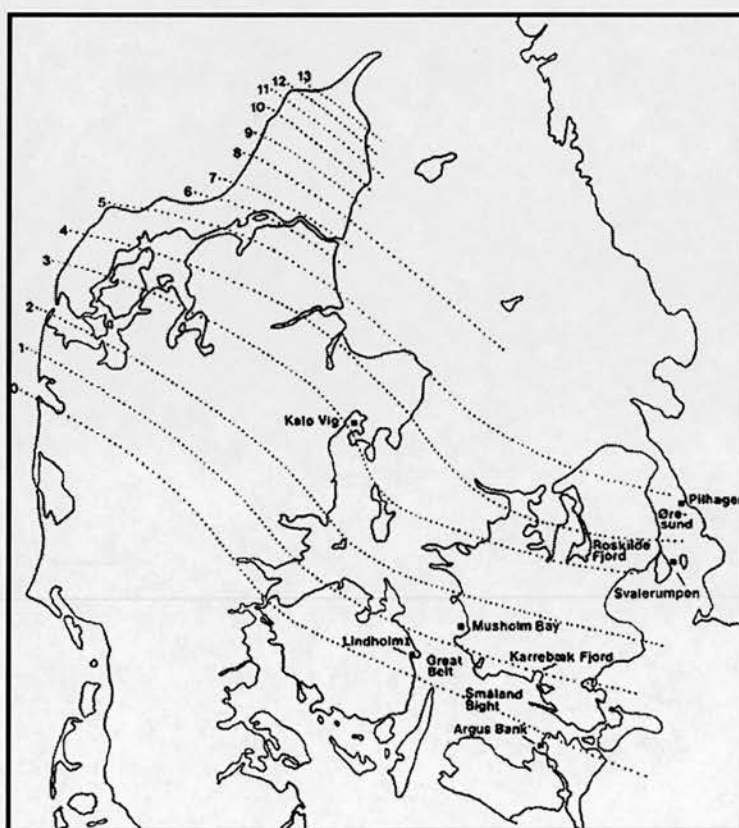


Figure 2.4 Map of Denmark with tilt lines indicating isostatic rebound in meters since the Litorina Sea transgression (after Fischer 1995).<sup>32</sup>

Since coastal Mesolithic peoples lived during a period of dramatically changing environments, they had to contend, physically and mentally, with constant adaptation (Larsson 1995). The sea level change would have inundated coastal

<sup>32</sup> Fischer (1995) cites the original isostatic measurements published by Mertz (1924)

settlements, affected soils and vegetation while creating new environments, including those valued for their fishing potential. This process submerged early and middle Mesolithic sites, but also affected younger Ertebølle sites south of the tilt, which can be found underwater, up to 5m depth (Malm 1995).

Evidence from the Storebælt suggests that during the period from 7000 – 6200 BC sea level rose from –27m to –9m, or 2.3cm per year. This rise may have been even faster during the last two hundred years of this period based on dates from Avernakø (Christensen *et al.* 1997). “A rate of rise of 2-3m per century would have been noticed by the contemporary population. In flat areas it would have led to significant displacement of the shoreline. Islands would have been submerged and settlements would have to move during the lifetime of single individuals.” (Christensen *et al.* 1997; 50).

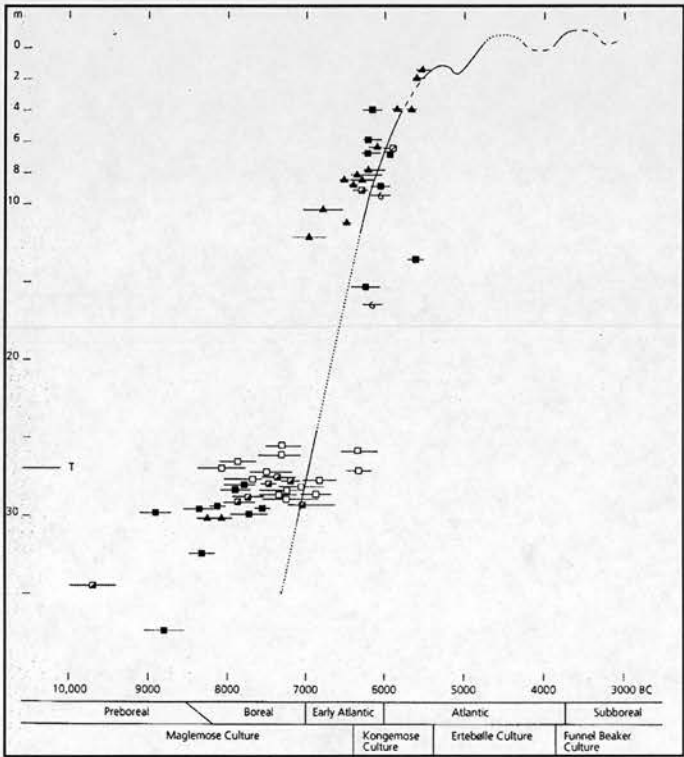


Figure 2.5 Radiocarbon determinations and rate of sea level rise in the Storebælt (after Christensen *et al.* 1997). Rate of sea level rise is steepest during the Maglemose and early Kongemose cultural occupations, with a later peak during the early Ertebølle occupation during the middle Atlantic period.



## Submerged forests

Submerged forests have been observed throughout northern Europe for centuries (e.g. Dawkins 1870) and used to measure transgressions through radiocarbon determinations and dendrochronology for several decades (e.g. Campbell & Baxter 1979; Fischer 1997b). During times of rising sea levels trees at the edge of the sea are drowned by the rising groundwater before they are eventually inundated. They then become waterlogged and covered by sand and mud, which can preserve stump and root systems (Fischer 1997b). Sea level change, changes in flora, and the dammed waters of the western Baltic region would have produced deposits, both complex and rich in paleoenvironmental data (Mathiassen 1997).

Environmental and transgression data come from the submerged forests of Kongemose site of Femø Skollerev in the Småland Bight. A radiocarbon date from a preserved oak stump yielded date of c.7040 BP while typological dating of related artifacts also suggests early Kongemose material culture (Fischer 1993). This site is seminal, because the stump itself is a good indicator for sea transgression at a defined date, and at a measurable depth. This data can then be applied along with other indicators to form a sea level rise curve (fig. 2.5), and facilitate paleocoastline reconstruction (Christensen 1995), which can then be applied to predict locations of submerged Mesolithic sites (Fischer 1993). There are problems with dating a transgression solely from submerged trees since it is possible that individual trees may have died and been transgressed later, with their root systems preserved in place. Obviously, the greater the number of individual trees available for dating, the stronger the statistical measurement of coastline becomes. In the rare case of one individual oak tree from Fedkrog, however, it appears that root systems stretched out horizontally along the surface clay in search of land not subjected to rising groundwater, or the encroaching saltwater (Fischer 1997b).

During the middle Maglemose period, it appears, according to such curves, that the sea level rose between 4-5cm per year (Christensen 1995). Radiocarbon determinations have produced sea-level curves showing an average of only 1cm of

sea level rise annually during the later Maglemose, and the middle and late Kongemose periods (Fischer 1995). On the seabed of the Storebælt, pine trees have been found at 30m depth south east of Romsø (Fischer 1997b). Alder, oak, elm and lime are found in shallower waters. The deeper finds of pine, dated to c.8100 BC are the earliest known pine from Denmark and demonstrate the cooler environmental conditions in existence 10,000 years ago. The species found in shallower water colonized the region after temperature increased after the pine declined based on pollen records (Jensen *et al.* 1999).

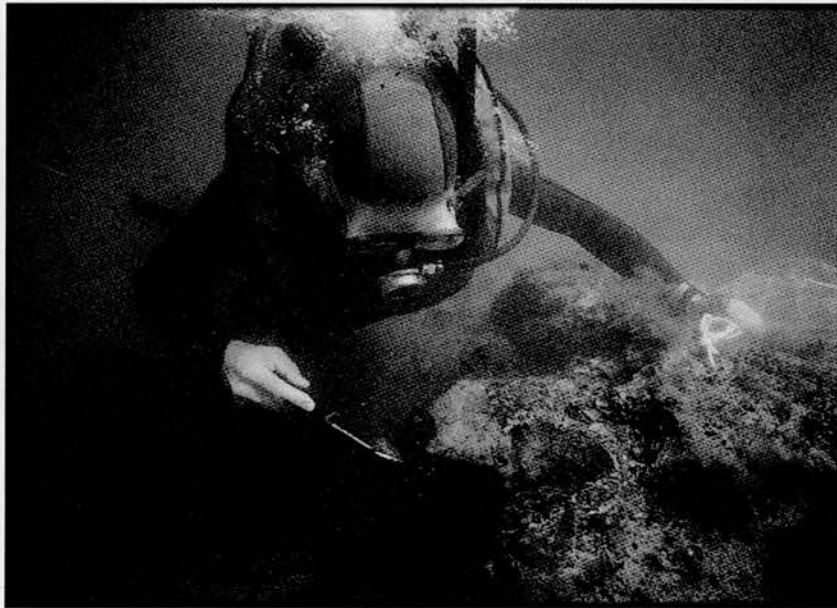


Figure 2.6 An underwater archaeologist takes a sample from a 7200 year old tree stump (Fischer 1997b).

Growth rings of submerged trees are studied through dendrochronology. At Halsskov Fjord, 63 oak samples from 9 locations were collected and analyzed (Christensen *et al.* 1997). Growth rings were measured and an attempt was made to create a curve using these samples. Since the Danish unbroken dendrochronology curve had not previously expanded so far back into prehistory, a more complete curve from Germany was utilized in a comparison, and results indicated a Danish curve spanning 359 years from approximately 5000 BC (Christensen *et al.* 1997).

## **Sea conditions**

Atlantic and sub-boreal marine environments have been discussed, regarding transgression and shore-displacement, however other variables such as tides, salinity and currents are important to determining the way in which underwater archaeology is conducted in any region and these variables must be addressed. Tidal changes within the coastal Danish waters are said to have changed, perhaps caused by the interaction of the Baltic and North Seas (Christensen 1995). It has been suggested that such a change in tidal activity would have impacted marine life, particularly the species crucial to the subsistence of Mesolithic peoples. This theory will be examined later within the chronological framework, and in relation to the final Mesolithic and the introduction of domesticates. Temperature and currents also affect sites, preservation, and accessibility for underwater archaeological work. As will be discussed later, sea currents too are important in the discussion of site location models for prehistoric fishery sites (Fischer 1993, 1995).

The modern temperatures of Danish waters surrounding the eastern islands of the Baltic varies greatly by season. Sea conditions are controlled by atmospheric variables, with average surface-water temperature varying between 0-2° C in February and 18° C in August. Bottom temperature, which fluctuates less than shallow waters, varies between 4° C and 12° C depending on both depth and season (Buch 2006). Additionally, tidal activity in eastern Denmark and southern Sweden spans approximately 0.5m of fluctuation, a minimal amount compared to many of the world's large oceans and seas. Salinity levels of the Baltic Sea average just 6‰ (Winsor *et al.* 2001).

## **2.2 Presupposition Model for Stone Age Underwater Survey**

Coastal settlements differ in quantity, size, artifact quantity and quality, seasonal indicators, and overall preservation compared with inland sites (Fischer 1995). There is therefore little doubt that valuable and original information has come from underwater archaeology in southern Scandinavia. Fischer cites three primary reasons

to study submerged Stone Age sites: 1) preserved organic material 2) new environmental data 3) Alternative information contributing to theories of adaptive strategy. Many of the sites discussed herein were not discovered accidentally. Discovery of many submerged sites are the result of active survey by underwater archaeologists and many sites were found using a model for presupposition of Stone Age sites (Fischer 1993). However, some of the initial and important discoveries, such as submerged forests, and the skeleton of Korsør Nor (fig. 2.23), were discovered in the middle 20th century by military, sport divers or other non-archaeologists (Fischer 1995, 1997).

Systematic underwater Stone Age excavation was initiated in 1976 (Grøn 1995b); by 1985 there were 10 recorded sites in the Småland Bight: the marine area which forms a bay and separates the islands of Falster, Zealand and Lolland in South eastern Denmark. Interviews with those who had fished in the early 20th century, established which species were caught, which were desired, and what methods were used; such as line, trap, nets, etc. Additionally, specific fishing spots, seasonality, and details of the catch were discussed (Fischer 1993).

It became evident that there were topographical similarities in these sites. Fischer's "fishing site location model" was thus created by studying the nature of the topographic location of fishing sites (Fischer 1993, 1995, 1997, 2006). These were common locations where fish swam, and provided excellent areas to trap or net a fisherman's catch. Hence the model for Stone Age underwater site location states that "settlements were placed on the shore immediately beside good sites for trap fishery. Such places were at the mouths of streams, at narrows in the fjords, and on small islands and promontories close to sloping bottoms in the fjords." (Fischer 1993, 66) As a method of control, areas which were not considered promising for marine resource exploitation were surveyed with negative results. It was determined that Stone Age settlement sites and their discovery were not random. Thus, the negative data acquired by the underwater surveyors was valuable in proving the accuracy of the model.



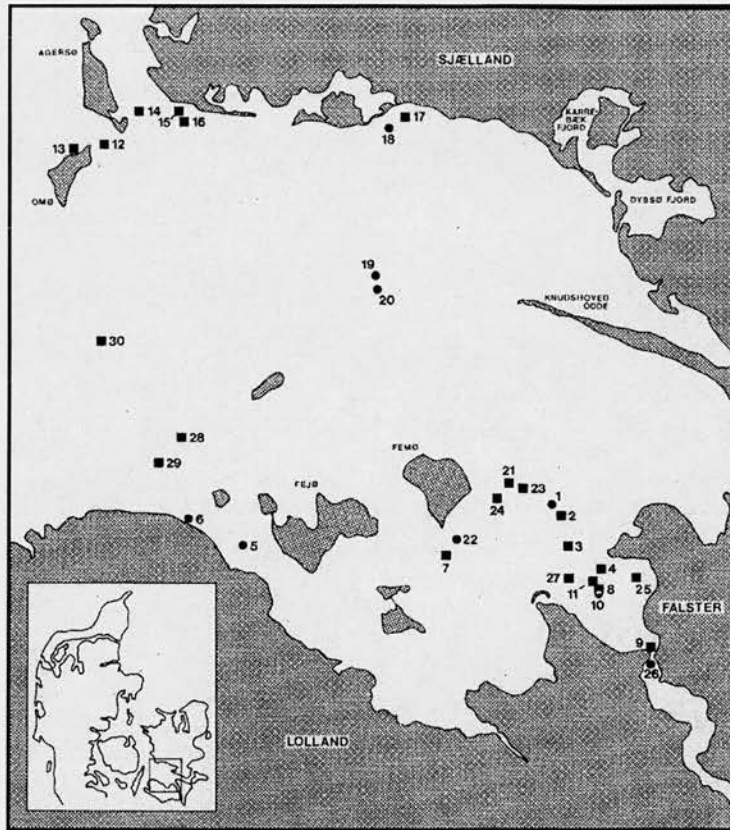


Figure 2.7 Locations in the Småland Bight from the 1985 and 1986 survey. 27 – Vigsø Skal, 30 - 'Malmgrunden' were two of the most comprehensive sites from this survey (after Fischer 1993).

In 1985, a two day initial survey was conducted to test the young hypothesis based on the topographic assumptions of the existing underwater sites in Denmark. Using Royal Danish administration of Navigation and Hydrographic charts, at a scale of 1:70,000 (fig. 2.8), locations were determined and plotted, and divers were sent to investigate these areas of potential interest (Fischer 1993).

Results were overwhelmingly positive, including the discovery Vigsø Skal and Malmgrunden. In total, by all statistical definition, the site location model proved >80% effective (Fischer 1995). The number of Kongemose and Ertebølle sites in southern Scandinavia, in particular, has increased dramatically with the adoption of this survey strategy. This method also helped define the importance of coastal



variables, which have disturbed the artifacts over time, exist, including sea transgressions, erosion, currents, weather, tides, and human activity. Therefore, interpretation of site taphonomy based on surface finds is not generally possible, as it is not often possible to state with certainty that a submerged surface finds are found *in situ* in Danish coastal waters (Fischer 1993).<sup>33</sup> Finds from the seabed discovered during initial survey can be considered potential archaeological indicators for more extensive submerged cultural material.

### **The presupposition model: defined in phases**

Since the initial two day survey in 1985 produced such positive results, a full month of survey was carried out in 1986, whereby 30 sites were discovered in the Småland Bight (Fischer 1993). In addition to visual survey, in some cases small test pits were dug by hand to investigate for the presence of archaeological material below the seabed. During the survey, in best conditions, it was possible to conduct three short dives per day while air tanks were refilled aboard the boat, en route to the next location. As defined by Fischer (1993), the survey model can be broken up into three phases.

Phase I – Map Plotting

Phase II – Localization and delimitation for sites by echo-sounder

Phase III – Mark the theoretical site with a marker buoy, and dive to investigate

Fischer continues to states that “... the model and working method described can be applied to the recording and protection of undersea Stone Age settlements in many other countries of the world.” (Fischer 1993, 57). The sites discovered by the application of this model are found within the following discussion of southern Scandinavian Mesolithic and early Neolithic chronology.

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<sup>33</sup> This is similar to other sites in Europe in which finds were discovered after having been eroded out of paleosols (Mømber 2000; Geddes *et al.* 1983), however different from those sites where there are architectural features recorded *in situ* (e.g. Galili *et al.* 1993, 1997).

## **2.3 The Mesolithic of Southern Scandinavia**

Originally suggested as a residual category used to define the end of the Paleolithic and the beginning of the Neolithic, Mesolithic European groups are considered the last foragers and did not use polished stone tools, nor did they produce pottery<sup>34</sup> (Price 1991). Fischer (2002) has defined the end of the Mesolithic in Denmark, not by the introduction of polished tools, pottery, or sedentary lifestyle, but through the introduction of agriculture as the mainstay for subsistence economy. Given this definition, the Mesolithic of southern Scandinavia extends from the preboreal to the late Atlantic, over 5,000 years (Karsten 2004).

### **Selected aspects of Mesolithic archaeology from southern Scandinavia**

Selected features of Mesolithic archaeological record are discussed herein to provide context for the chronological discussion, and the underwater archaeological contribution. Additionally, midden and bog sites, Mesolithic burials, art and fishing are mentioned. Since each of these subjects can be discussed at length, their descriptions are not meant as comprehensive syntheses, rather they are intended to establish context within the greater archaeological record and the historical importance of these aspects from the Mesolithic and early Neolithic of southern Scandinavia, in order to describe the underwater archaeological contributions.

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<sup>34</sup> The introduction of pottery however, will be addressed, and shown to have been present in the final stages of the Mesolithic.



C14 bc	PHASE	CHARACTERISTIC ARTEFACT TYPES
3000	EARLY FUNNEL- BEAKER	
3500	LATE ERTEBØLLE (Ålekistebro)	
4000	MIDDLE ERTEBØLLE (Stationsvej)	
4500	EARLY ERTEBØLLE (Trylleskoven)	
5000	LATE KONGEMOSE (Vedbæk)	
	EARLY KONGEMOSE (Villingeby)	

Figure 2.9 Chronology of southern Scandinavian Mesolithic and early Neolithic based on eastern Denmark (after Vang Petersen 1984).

### Køkkenmødding (kitchen middens)

The Køkkenmødding of southern Scandinavia are perhaps the single most recognized element from the late Mesolithic in the region (Thorpe 1996). A comprehensive history of Danish Køkkenmødding, or kitchen middens, is found in the history of the Danish examination of these features throughout the 19<sup>th</sup> and 20<sup>th</sup> centuries compiled by Fischer & Kristiansen (2002). The earliest shell heaps from Denmark-Scania come from the Kongemose-Ertebølle transition (Fischer 2002). Excavations from 1985 – 1992 at the largest known kitchen midden, Bjørnsholm, North Jutland, show that this site was occupied from the Ertebølle through the early Neolithic TRB culture (S.H. Andersen 1991). The <sup>14</sup>C determinations from kitchen middens at Norminde and Bjørnsholm date from the Ertebølle (S.H. Andersen 1991), with ages indicating the latest Ertebølle occupation at c.3950 BC (Fischer 2002). The Ertebølle sites of Limfjorden show a first accumulation of shells around

4000 BC, with substantial accumulation beginning 200 years later, and lasting over the following 600 years (Larsson 1990). Shell middens in southern Scandinavia are discussed for their social role, particularly relating the special analysis of burials within the middens, and proximity to living space. Thorpe (1996, 82) states that “the middens were either sites of permanent settlement or repeated seasonal occupation” and that they would have “taken on a considerable degree of significance as a focal point in the social landscape.”

### **Bog sites**

Wetland deposits and bogs can provide exceptional preservation of archaeological material and provide great detail from organic material (Price 1991; Coles & Coles 1996). Wetland sites, however, are here distinguished from underwater archaeological sites, and are thus included only within the greater overall context of the Mesolithic-Neolithic transition of southern Scandinavia. There appear to be more bog sites from the early Mesolithic, perhaps due to infilling lakes. Mesolithic huts have been found in bogs, generally constructed from bark and reeds, with early Mesolithic huts consistently slightly smaller in size than the later Mesolithic dwellings (Larsson 1990). These bog sites have been interpreted as temporary or seasonal camps, a thesis supported by the nature of the dwellings themselves, as well as the traces of the population’s collection strategy, and available archaeological evidence.

Although these sites are considered highly informative (Larsson 1990; Price 1991), not all archaeologists are convinced by the importance of bog sites. “The small, briefly inhabited inland bog settlements that South Scandinavia is so famous for, do surely not give an adequate impression of the middle and late Mesolithic social organization.” (Fischer 1995; 372). There are examples of bog sites which are of exceptional quality and must be noted however; the Maglemose and Åmosen bogs are discussed later in further detail.

## **Mesolithic burials**

There appear to be three kinds of burial practice in the Mesolithic of southern Scandinavia (Karsten 2004): Flat earth graves, cremation graves, and burial at sea. Evidence of the third, burial at sea, comes from a Danish submerged site Møllegabet (Grøn & Skaarup 1991). Of approximately 700 Mesolithic burials found within the whole of Europe, about 100 come from Scania alone (Karsten 2004), mainly from the site at Skateholm.<sup>35</sup> Grave goods, including artifacts such as pendants, beads and flint blades have been recorded, and in addition ochre is found in late Mesolithic burials (Larsson 1990; Thorpe 1996). The substantial burial record remains amongst the most widely known elements of Mesolithic features of southern Scandinavia (Thorpe 1996).

## **Mesolithic art**

Mesolithic portable art is found mainly in the form of patterned carvings on bone, antler or wood (S.H. Andersen 1985, 1987; Larsson 1990; Thorpe 1996). Portable art is not the only evidence for decoration, indeed examples of engraved stone have been recovered in southern Scandinavia and cave art in Norway has been interpreted as late Mesolithic (Larsson 1990). There have also been cases of exceptionally well preserved Mesolithic art recovered through underwater archaeology, such as the examples from Tybrind Vig (S.H. Andersen 1985; Malm 1995). Hence, the underwater contributions are highly important to the archaeological record in regard to decorated objects in southern Scandinavia, and will be discussed within the context of individual sites.

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<sup>35</sup> This statistic, however, must be taken within context, since the Mesolithic is here defined by the introduction of domesticates and spans 5000 years in Southern Scandinavia. This implies that later Mesolithic peoples of this region existed contemporaneously with Neolithic societies in much of Europe. This presumption is based on the fact that the Mesolithic did not end in Scandinavia until c.3950 BC (Fischer 2002; Andersson 2004). These younger Mesolithic sites would allow for the discovery of more preserved burials.

## Maritime transportation & trade in the Mesolithic

Late Mesolithic Ertebølle groups living on the Danish islands and Scania would have had access to agricultural communities to the south, using dugout watercraft of up to 10m in length (S.H. Andersen 1987), with examples dating back to 5510 BC (6550±105 BP, K-6012) (Christensen 1997, tab. 1). Long-distance Ertebølle trade was directly related to seafaring (Larsson 1990; Lübke & Hartz 2000; Klassen 2000; Fischer 2002). Experimental archaeology has shown that routes, such as the 18km channel separating Lolland from Fehmarn, Germany, can be traveled on glassy waters during calm conditions; this route would have taken approximately six hours using Ertebølle technology (Fischer 2002).

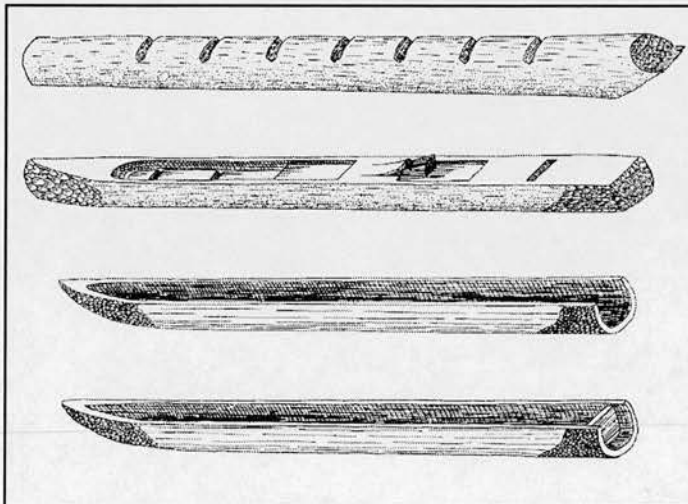


Figure 2.10 A reconstruction of a Mesolithic logboat in stages of construction (after Christensen 1997).

The results also provide evidence for contact and trade of material culture and perhaps overall economy. It took mere hours to make the crossing, though it would be centuries before the Ertebølle groups of Denmark-Scania adopted a Neolithic subsistence economy (Larsson 1990; Fischer 2002).<sup>36</sup> It has been suggested that the delay in the Neolithization of southern Scandinavia was due to the abundance of resources provided on the coast (Rowley-Conwy 1986). Resources, such as skins and furs, as well as flint tools such as axes, would have been used in trade with

<sup>36</sup> The question of agricultural adoption versus a Neolithic colonization of southern Scandinavia will be addressed later in this chapter.



agriculturalists to the south. Green-black and olive green stone appear to have been sought as prestige goods (Klassen 2000, fig. 1), and “exotic” foods may have been part of the exchange network (Fischer 2002). Along with a variety of logboats recovered from the late Mesolithic, a number of wooden paddles have also been discovered (S.H. Andersen 1987; Lübke & Hartz 2000), many of them underwater.

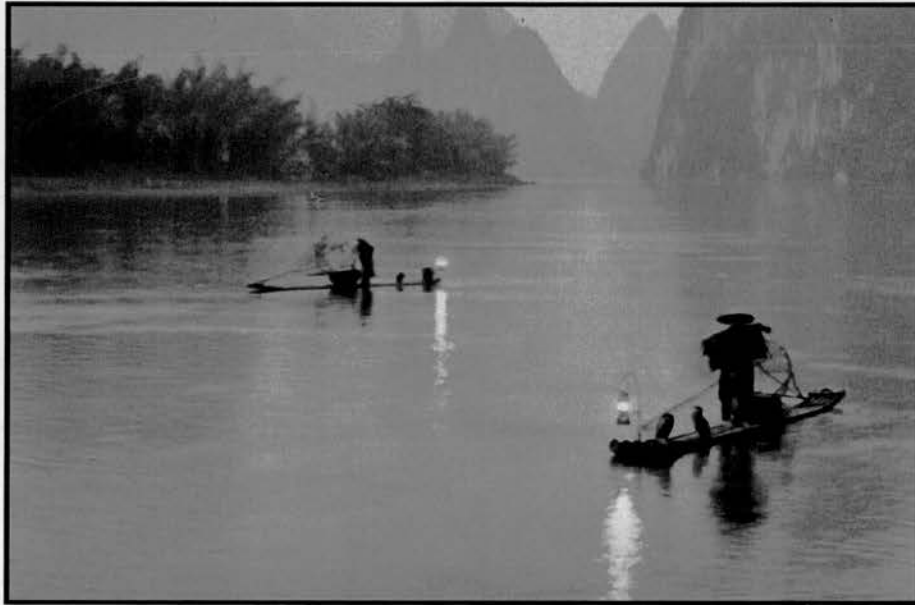


Figure 2.11 Ethnographic example of 20<sup>th</sup> Century fishermen in China (photo by Anne Xu).

### **The Mesolithic fishing industry of southern Scandinavia**

Fishing is considered an important element in the Mesolithic culture of southern Scandinavia (Pedersen 1995, 1997; Enghoff 1995; Fischer 1995, 2006) and throughout Europe (Bonsall 1985; Zvelebil 1998). Picard & Bonsall (2004) define the four categories of fishing relevant to Mesolithic cultures as: hook and line, net, spear & harpoon, and weirs & traps. Passive fishing in the Mesolithic of southern Scandinavia, however, has been conclusively proven to have been practiced by fishing structures, and traps as well as the variety of fish bones recovered (Pedersen 1995; Enghoff 1995).

Fishing traps and structures were extremely important to the subsistence economy of the Mesolithic coastal Scandinavians (Pedersen 1995, 1997; Enghoff 1995; Fischer 1993, 1995, 1997) and continued to be used throughout the early Neolithic (Pedersen 1997; Fischer 2006).

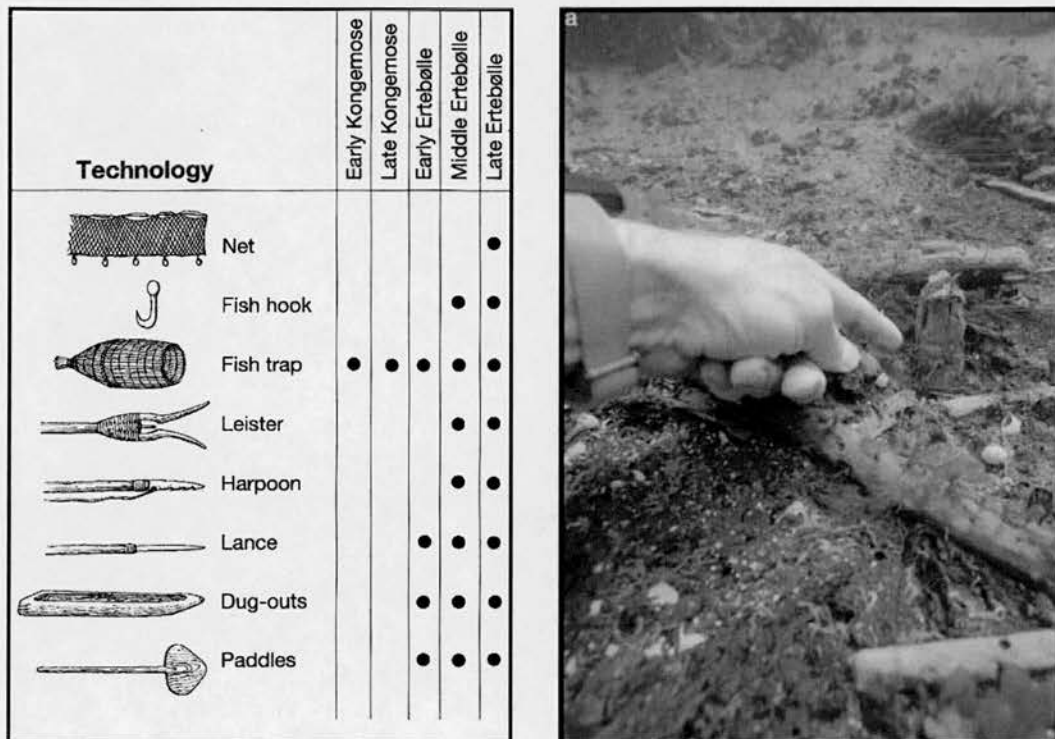


Figure 2.12 (left) Schematic of fishing implements during the Mesolithic. (after S.H. Andersen 1995) although it must be noted that Andersen has not listed the fishing net from Antrea (Pedersen 1995). (right) A vertical pile *in situ* next to horizontal stakes from a Mesolithic fishing structure, Tudse Hage, Denmark (Fischer 2004).

The large structures would have been built and rebuilt, and serve as evidence of permanent settlement, and social organization. “The construction of such traps required considerable investment. To operate them, however required a minimum of work.” (Pedersen 1997; 141). Pedersen continues to explain that passive fishing during the Mesolithic and Neolithic would have required: 1) that the right materials be obtained in large quantities 2) the considerable labor invested in building such an apparatus 3) the possibility of distributing or preserving the catch not immediately eaten by the families involved 4) the right to the fishing place and to the harvest of the catch. Fish fences from the Halsskov area were found from both the Mesolithic and Neolithic and have survived through the millennia providing evidence for their

construction, and installation (Pedersen 1997). Additionally, the oldest fishing net, from Antrea, has been dated to c.9300 BP (Pedersen 1995), while the oldest Eel trap from Denmark is dated to c.7080 BP (Fischer 1993).

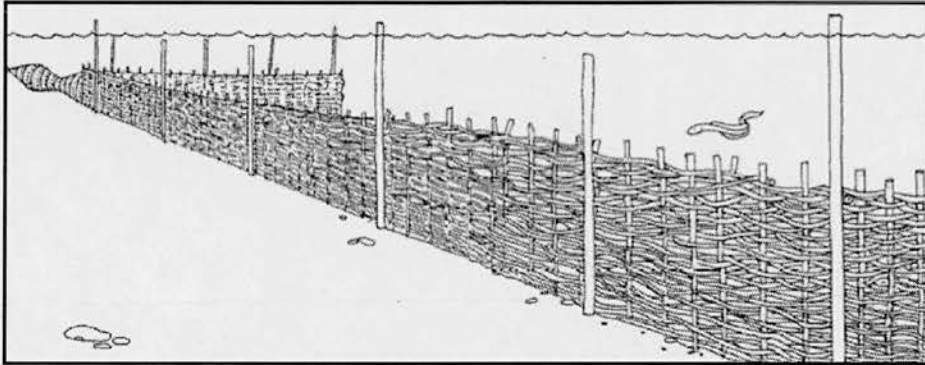


Figure 2.13 A reconstruction of a fishing structure from the late Stone Age. The removable trap at the end would probably have been accessed using a logboat (after Pedersen 1997).

Enghoff (1995, tab. 1) has published data of the discovery of 41 species of fish from 14 locations identified from the Mesolithic in southern Scandinavia.

Sites from Limfjord, the former island from Djursland, Egå Fjord, Norsminde Fjord, and Vedbæk have shown that Eel was exploited as a primary source of food, while small fish were caught inadvertently. In some coastal environments, such as at Bjørnsholm and Ertebøllem freshwater fish seem to dominate. This is possibly due to salinity changes and variable conditions of the sea during the Mesolithic.

Additionally, seasonal fishing is inferred by the presence of migrating summer species (Enghoff 1995).

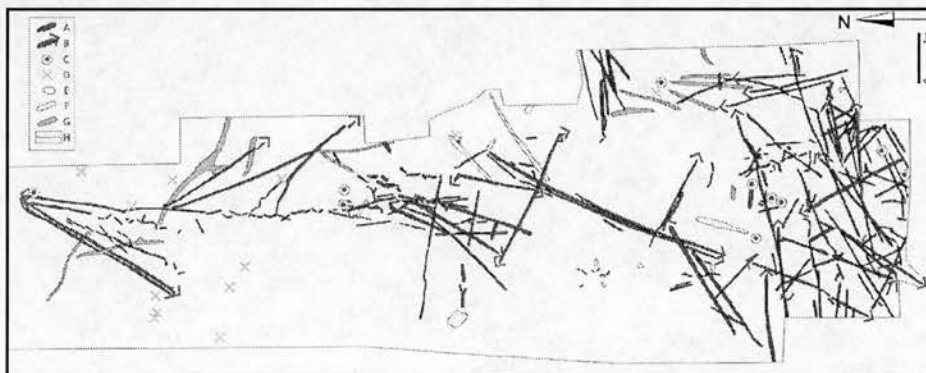


Figure 2.14 Plan of the fish trap at Halsskov South (after Pedersen 1997) A) rod B) Pointed Rod C) Vertical stake D) worked flint E) Natural Stone F) Water-rolled tree G) root H) excavation boundary

While it is commonly accepted that forest management was taking place throughout the Neolithic (Fischer 2002), evidence of forest clearance existed in the Mesolithic from sites such as Halsskov fishery station. Hazel coppices formed into standing panels illustrate the way in which Mesolithic fishers would have required at least some, if not extensive knowledge of the local flora. Thus it appears that the local environment was being manipulated for subsistence economic purposes some 2000 years prior to the Neolithic (K. Christensen 1997).

### 2.3.1 Mesolithic Chronology of Southern Scandinavia by Cultural Occupation

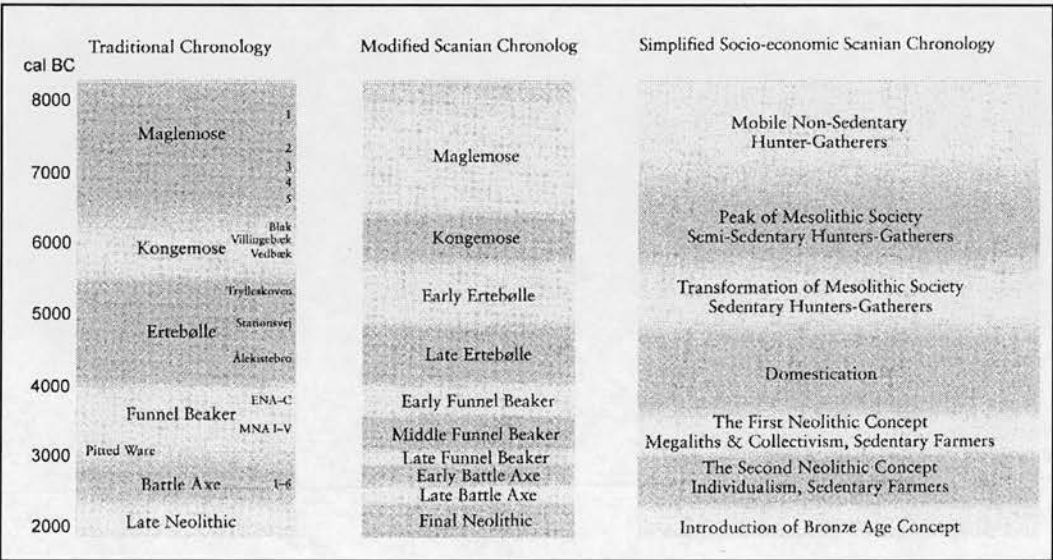


Figure 2.15 Mesolithic and Neolithic timeline of Scania showing (left to right) traditional, modified, and Socio-economic chronologies represented (after Andersson *et al.* 2004).

The chronology herein provides context to illustrate the significance of underwater archaeology and submerged Mesolithic and early Neolithic sites of southern Scandinavia. Andersson *et al.* (2004) define Scanian chronology as compared to traditional timelines of southern Scandinavia (fig. 2.15). The dates of the cultural phases found herein are based on this recently published chronology.



## Maglemose culture c.8000 – 6500 BC

Excavations at the Maglemose bog, Mullerup, Zealand in 1900 were responsible for the first discovery of the culture known for its microliths, core axes and Leister points (Larsson 1990). It became apparent in the early 20th century that the Maglemose were a pre-farming culture (Andersen 2002), since the only presence of domesticates came from skeletal remains of dog. Despite this, Mesolithic diets are often more complex than might be expected (Larsson 1990). Evidence from an individual burial at Bäckaskogs Slottsmark in northeast Scania, shows that this adult female had a mainly terrestrial diet (Karsten 2004). It has been suggested that the settlement strategy of early and middle Mesolithic peoples followed large game animals to inland lakes, and that there would have been some interaction with inland resources, particularly in northern Scania. Dietary analysis from Denmark, however, shows an increased reliance on marine resources as the Mesolithic progressed (Fischer 2006). Through a series of  $^{14}\text{C}$  dates, samples of hazelnut and burned wood have shown that the small huts from these sites contain bone points, evidence of a bow, fishing spears, and a paddle. The latter two artifact types suggest that Maglemose peoples of Denmark were at least partially reliant on maritime resources, and would have used boats for marine transportation and fishing (Grøn 1995).

Such severe environmental fluctuations took place during the peak of the Maglemose (Björck 1995; Christensen *et al.* 1997) that nearly all coastal sites were transgressed, in some cases numerous times (Grøn 1995).<sup>37</sup> Grøn has interpreted thirty Maglemose sites, and while some of them are found near the shore, none of these sites are underwater. This does not however indicate that underwater Maglemose sites do not exist however. It is argued that Maglemose sites are mainly found inland as a direct result of transgression which submerged coastal evidence (Christensen 1995). Larson (1990, 272) states that “most sites lie at the inlets or

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<sup>37</sup> This is shown through the available evidence and sites described by Grøn in his doctoral dissertation *The Maglemose culture: the reconstruction of the social organization of a Mesolithic culture in Northern Europe*

outlets of large lake basins. Settlements were also located on chains of hills and on the edges of funnel valleys.”

According to Grøn, Maglemose dwellings are found in the form of huts, pits, and hollows, and recent evidence has been used to suggest the presence of tent rings at a Maglemose encampment (Grøn 2003). Ulkestrup I & II, from the Åmosen Bog in central Zealand (Grøn 1995) and from Hjemsted, southern Jutland (Grøn 2003) show evidence of Maglemose huts. The dwellings from Ulkestrup have also been used to interpret seasonality and social organization. It appears, based on the limited evidence, that the nuclear family organization of a single, or perhaps two families were present at these occupations (Grøn 1995). According to Grøn, encampments were separated, possibly suggesting a seasonal occupation of sites near and far from the coastline. This seems to have been directly related to weather conditions and wind direction, evidenced by site orientation.

The huts at Ulkestrup consist of bark floors; and hut I was the first evidence of the superstructure of a Maglemose dwelling (Grøn 1995). Thick stakes surround the floor layer. The huts have been interpreted to imply seasonality, based on their orientation to the shoreline. Ulkestrup II and Ia type dwellings are defined by their position <5m from the coastline, and are generally oriented to protect against the prevailing West and North West Winds. Ulkestrup Ib type sites are located further from the coast (20-200m) and are found up slope, on the edges of plateaus. The latter are oriented to protect against easterly and southerly winds. Such protection from prevailing winds has been seen as seasonal stratification of sites based on orientation of settlement and prevailing wind direction (Grøn 1995). C13 values in skeletal remains were also used to investigate Maglemose seasonality, indicating a diet based on terrestrial, and perhaps various other origins. Dental evidence from fauna consistent with the types of species found at the early Mesolithic type sites at Mullerup has also provided support for seasonality (Carter 2001).

Maglemose social organization can be inferred based on size of the encampments and ethnographic comparison with contemporary hunter gatherers (Grøn 1995). This

evidence however, is speculative and relies on assumptions, such as traditional male and female social roles. Grøn (2003, 703) states that “an interesting change appears through the Maglemose Culture. In its early phases the one-family units seem to dominate totally. In the period from 7000 – 6000 BC, meanwhile, the units interpreted as ‘two-family dwellings’ make up 67 per cent of the sites with identified patterns.” Nevertheless, information which can be inferred about Maglemose dwellings is still limited in quantity and availability. Since so much of the Maglemose coastal occupied territory of Denmark- Scania has been submerged, it is likely that big-picture archaeological questions relating to settlement pattern, marine transportation, exchange, and diet may eventually be clarified by underwater archaeological survey and excavation (Grøn 1995).

The oldest known Scanian grave is associated with the late Maglemose, possibly as old as 7000 BC (Karsten 2004). The individual from Bäckaskogs Slottsmark, previously mentioned for the contributions of her dietary analysis, was initially thought to have been a male. It was only later realized that the individual was female, and has since become known as the Barum woman. The well preserved skeleton was found with grave goods, a bone point and an object assumed to be a needle, perhaps for knitting or constructing nets (Karsten 2004).

### **Kongemose culture c.6500 – 5500 BC**

The Kongemose cultural period signifies the peak of the Mesolithic society, as a culture of semi-sedentary hunter-gatherer-fishers. By the later stages of the Kongemose, the transformation of Mesolithic society into sedentary hunter-gatherer-fishers was underway (Karsten 2004). Kongemose sites are nearly exclusively coastal (Christensen 1995), or near inland lakes (Karsten 2004), and thus appear different from earlier Maglemose groups. This may be due to an increased cultural reliance on marine and aquatic resources, or the result of archaeological record and the impact of transgressions (Christensen 1995). Climatic events would have led to the accumulation of water in lakes formed from glacial runoff into undulating terrain (Björck 1995). Kongemose groups would have been drawn to these inland water

sources, probably following game during the drier time of the preboreal (Karsten 2004).

Kongemose shelters are rare in the archaeological record, though Kongemose huts at Aggemose are found as pit dwellings measured 10cm deep (Grøn 2003). Kongemose sites such as Segebro and Tågerup show that people were living at estuaries, bays and beside lagoons (Karsten & Knarrström 2001; Karsten 2004). These long narrow strips of occupied land were located between bodies of water and forest, which provides insight into the people, land use, and their relationship with the environment. Sea level rise flooded and sealed the Kongemose settlement at Tågerup when water levels covered the site c.5000 BC (Karsten 2004). The Tågerup settlement was occupied from 6500 – 4800 BC and underwent a series of progressions of retreat from the encroaching water. Artifacts discovered at Tågerup include an axe haft made from antler, which had clear markings (Karsten & Knarrström 2001, fig. 2), and was dated to the middle Kongemose c. 6400 BC.

During the 5000 BC transgression at Tågerup, the nutrient rich water left a layer of compact gyttja, which created a natural anaerobic environment. This allowed for the preservation of material, which would not have survived otherwise and includes plant fibers and wood. Submerged stakes, or vertical piles, leading into the water, are interpreted as the foundations of prehistoric docks (Karsten 2004). These would presumably have been used to access small boats, may have provided access to fish traps, or baskets, and would constitute the sole example of such a gangway from the Mesolithic (Pedersen 1995; Karsten 2004).<sup>38</sup> There is no clearly defined fishing structure found associated with these sails, however a conclusion of the presence of a prehistoric gangway used for fishing is not possible.

It appears likely that Kongemose burials took place away from the residential sites. Grave materials and corpse positions show a similarity between Danish and Scanian

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<sup>38</sup> Evidence of a linear stone feature has been found near a fish weir and may be interpreted as a path or gangway used to retrieve a late Mesolithic fish trap at Timmendorf-Nordmole in Wismar Bay (Lübke, pers. com.).



Kongemose burials, however only two excavated Kongemose graves from southern Sweden exist (Karsten 2004). It has been suggested that the Kongemose treated their dead differently from later Ertebølle groups, burying them closer to their living areas. Both of these two burials come from Tågerup, and are found 100m away from the centers of activity (Karsten 2004).

The Kongemose culture were formerly referred to as 'early coastal culture' and were known for their tool kit of microliths, long symmetric blades, and flint edged bone points. Hunters used bows and arrows with trapezoid and oblique points (Karsten 2004), while rowan, pine, and birch were used for shafts of arrows. Microliths and narrow trapezes were sometimes attached as barbs (fig 2.16). The Kongemose were not associated with intense tree felling, or mass clearance, this does not imply, however, that land rights did not exist during the Kongemose cultural period. Indeed, fishing sites can indirectly suggest territoriality at occupations of productive locations. (Pedersen 1997). Such claims however are not substantiated by direct evidence, and population levels could suggest that such rights would have been less contested due to population density with relation to the quantity of advantageous fishing spots (Karsten 2004).

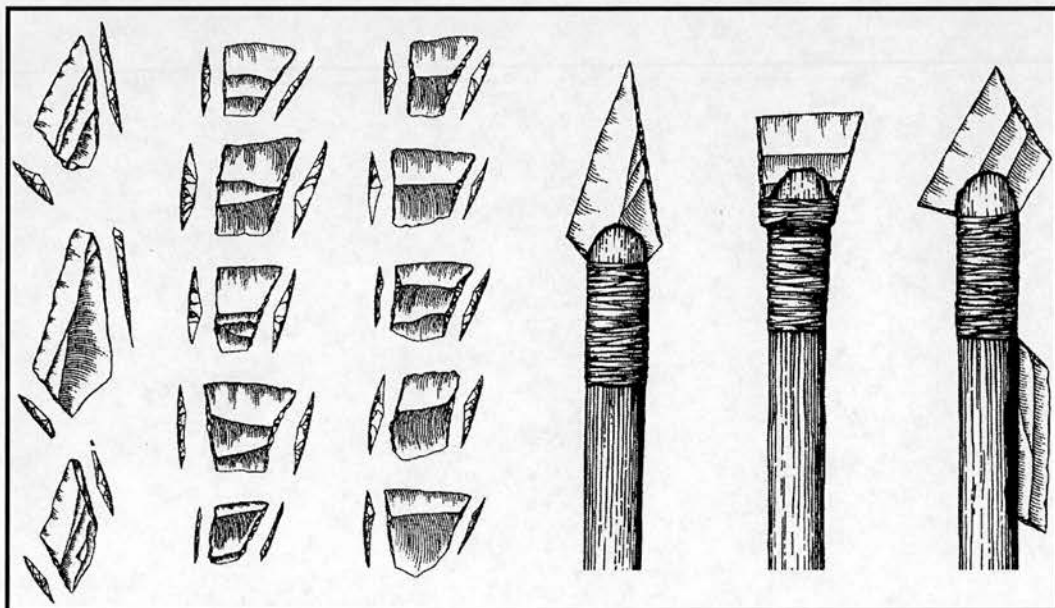


Figure 2.16 Microliths from Tågerup and their proposed hafting (after Karsten 2004).

Archaeological evidence of fish bones and fishing implements show an intensive exploitation of marine resources throughout the Kongemose cultural phase. Indeed the number of species of fish caught throughout the Mesolithic indicate a non-selective sample in local waters (Enghoff 1995). This also implies, that Kongemose technology, as with later Ertebølle fishing technique, relied on passive fishing, such as the overnight use of traps and weirs. The oldest dated isolated trap is dated to 6040 BC ( $7160 \pm 120$  BP), found at the settlement of Villingebæk (Pedersen 1995). As is the case with all Mesolithic fish weirs and isolated traps, there is no archaeological evidence to indicate any kind of gangway for fishermen to use to extract their catch. Instead, it is assumed that such activity was carried out using dugout boats (Pedersen 1995; Myrhøj & Willemoes 1997). It is possible that Mesolithic peoples were using water craft made from skins, as it has been suggested using ethnographic evidence (Picard & Bonsall 2004), yet there exists no direct archaeological evidence to support this speculation.

Although Price (1991) argues that Mesolithic hunter gatherers merely supplemented their diet with terrestrial foods, evidence suggests that Kongemose diet in Scania were both marine and terrestrial mixed diet, seen in human remains at Tågerup (Karsten 2004). Danish sites and southwestern Scanian sites such as Segebro, however, indicate a primarily marine diet. Isolated fish traps and funnels were made from willow or birch, with lime or pine frames, and were probably used as summertime fishing devices (Pedersen 1995). Seasonality is indicated by the sought catch: the common European Eel (*anguilla anguilla*) (Pedersen 1995; Fischer 2006). The Yellow variety of Eel is considered to have been a summertime catch while Silver Eels, a migratory animal, were more commonly caught in autumn, using fixed structures. The migratory Eels can be caught in abundance, and are a source of fat and protein. Eels are also valuable since they can be preserved by smoking or salting. This type of processing could lead to a surplus of storable food (Pedersen 1995). Apart from eel, herring was the dominant fish represented, while plaice, cod and salmon are present from Kongemose sites (Karsten 2004). Terrestrial mammals were also consumed, most commonly the red deer. Animals were not hunted only for their meat: fox, wildcat, wolf, and marten are thought to have been hunted primarily

for their fur, while beaver, bear and badger would have been a valued asset, providing both for high nutritional content and fur. Plant foods are difficult to assess (Larsson 1990) and have been suggested to have played only a minor role in Mesolithic diet (Price 1991). However, based on modeling, physiological constraints, and a lack of direct evidence due to insufficient preservation plant foods have been suggested to have been 25-35% of the diet (Karsten 2004). Hazelnuts are the sole exception to this pattern of omitted organic material, and are often present in the archaeological record (Larsson 1990; Price 1991; Karsten 2004).

The final Kongemose period took place between c.5900 – 5500 BC, and is known by the name Vedbæk, after a site on the Danish side of the Øresund (Larsson 1990; Karsten 2004). The final Kongemose period is said to have completely ended by 5450 BC (Vang Petersen 1984; Sørensen 1996). By the final Kongemose, it is suggested that increased productivity and semi-permanent dwellings led to higher efficiency and surplus. Regional variation in social and economic activity is a distinct possibility since there were likely both sedentary and non-sedentary groups in the early Ertebølle (Rowley-Conway 1998).

### **Ertebølle culture c.5600 – 3950 BC**

The Ertebølle are known for their simple flake industry, and continuation of intense coastal resource subsistence and near-shore habitation sites (Price 1991). Ertebølle people carved bone and antler (Larsson 1990; Thorpe 1996), lived in houses and buried their dead close to their everyday living space (Larsson 1990; Grøn 2003). Though there may have been knowledge of food production and agricultural peoples of neighboring regions, the Ertebølle maintained a highly productive use of marine resources (Pedersen 1995; Fischer 2006). This illustrates a diversity of food resources, which is, in terms of quantity of species, was much greater in the Ertebølle than in the earlier Maglemose culture (Price 1991; Karsten 2004) and was perhaps conducted in place of practicing animal husbandry (Fischer 2002). Intense exploitation of marine resources was achieved through the social activity of building structures, including traps, weirs, and nets, and involved scores of people for both

construction, and maintenance (Karsten 2004). While there have been no nets found from southern Sweden, there are direct examples from Denmark and indirect evidence from Scania in the forms of anchoring poles and sinkers (Fischer 1995).

Larger fishing installations would have required a group effort to operate efficiently (Karsten 2004; Fischer 2006). Since large quantities of raw material, would have been required to produce one of the larger Ertebølle fishing stations, this concerted effort of material collection, weaving wicker, driving vertical piles, laying nets and repairing the installations could only have been achieved communally (Pedersen 1997; Fischer 2006). This joint effort has been interpreted to suggest that the catch would have been shared by the group (Karsten 2004). Underwater archaeology is essential for understanding such fishing installations, and thus, according to this theory of social fishing, understanding the greater Ertebølle social structure.

During the Ertebølle 50% more species of fish were exploited than in the early Mesolithic (Price 1991), including cod and other deep sea fish (Karsten 2004). While deep sea fish appear in the archaeological record, this has been suggested to be situational and it has been suggested that there is no conclusive evidence that deep sea fishing was actively practiced in open seas (Picard & Bonsall 2004). The exception to this comes from sites at which deep sea conditions are found near shore, such as the fjords of Norway. Mammal hunting, both terrestrial and marine, continued to be crucial for diet. Marine mammals, such as seals and small whales were hunted, and butchered on location. Sandbanks are believed to have been used as butchery sites, such as those just a few kilometers from Saxå and Tågerup, which contained large quantities of seal bones. Terrestrial hunting was still carried out with transverse arrowheads, while blades, and hammer stones were also common tools of the day. Flint was, for the most part, found locally, and could have been used in trade with the neighboring people of the southern Baltic (Karsten 2004).

Ertebølle fishing structures discovered on a submerged islet between Zealand and Funen are dated to 5470 – 5210 BC at Halsskov South and 4840 – 4580 BC at Halsskov East (Pedersen 1995; Fischer 2006) and were found using the site



presupposition model (Pedersen 1995; Fischer 1995). Middle Ertebølle structures found at Nekselø seem to be similar to the later, larger Neolithic weirs, however they were probably somewhat lighter and smaller. The structures found at Nekselø were dated from the Mesolithic structure of 4490 – 4330 BC to the later Neolithic feature, which yielded several dates, the earliest at 3650 – 3380 (Fischer 2006, tab. 2). This implies that fishery stations would have provided more than enough food to sustain the fisherman himself, indicates a division of labor and may provide evidence of a surplus of food supply (Pedersen 1995; Fischer 2006). Such a potential for surplus has been used to explain the delay for the adoption of agriculture which occurs relatively late in southern Scandinavia compared with neighboring agriculturally-reliant populations (Larsson 1990; Price 1991; Fischer 2002; Karsten 2004).

Pottery was introduced to Denmark-Scania during the Ertebølle around 4700 BC (Fischer 2002), about seven centuries before the introduction of agriculture to the region. TRB, or Funnel Beaker pottery was introduced around the same time as the first evidence of domesticated livestock, c.3950 BC (Fischer 2002). The existence of pottery during the Mesolithic supports the hypothesis for a surplus and storage during the pre-agricultural Ertebølle.



Figure 2.17 An example of common Ertebølle pottery (after S.H. Andersen 1985).

Ertebølle groups had a substantial impact on the environment, utilizing the resources from the forest to build permanent structures, large scale fishing structures, and for fuel (Pedersen 1995, 1997). Hazel and lime were aggressively cut for fish traps, which were not only a source of food, but are also thought to have encouraged a

greater social cohesion. Reeds were used for dwellings and household utensils, as illustrated by pollen, which has been well preserved in anaerobic layers of gyttja. Late Mesolithic groups may even have had knowledge of basic gardening or early horticulture (Karsten 2004). Certainly, the quantity of wooden material needed to build and maintain the elaborate fishing structures indicate that systematic, perhaps deliberate, coppicing activity was undertaken (Pedersen 1995). Pedersen also implies that there would have been an increased potential to suggest that fishing rights would have been an important aspect of culture compared with the earlier Kongemose. This is argued to have been a potential cause for an adaptation of a sedentary lifestyle (Pedersen 1995, 1997; Fischer 2006).

The late Atlantic littorina transgression stabilized approximately 5400 BC (Christensen *et al.* 1997), and Tågerup emerged as a regular permanent village by 5300 BC (Karsten 2004). Ertebølle housing appears to have varied in size, shape, installations and even to have included “wall ditches” (Grøn 2003 7, 10). The dwellings themselves are represented by evidence of huts and tents, round houses, and large trapezoidal long houses (Grøn 2003; Karsten 2004); the latter are not dissimilar in shape to those found in the Neolithic long houses of Osłonki, northern Poland (Bogucki 1998). The dissimilarity in form of Ertebølle dwellings has been considered problematic (O. Jensen 2003). According to Jensen, archaeologists should assume that the Ertebølle culture had a ‘type-house’ as seen in contemporary Stone Age cultures, such as those in nearby regions. Through evidence provided from Nivå, eastern Zealand, Jensen suggests that sunken houses represent such a “type-house” of the Ertebølle culture. This suggestion is based on an assumed need for a common ‘type house’, which could artificially bias the definition of Ertebølle houses. Only when more substantial quantitative data becomes available can such a suggestion be scientific.

The burial site of Skateholm I in Scania contains 87 graves dating between 5600-4800 BC (Karsten 2004). Additionally, 11 dogs were found as were grave goods associated with the canine dead as well as with the human skeletons. Populations consisted of stocky, muscular individuals with a mean life expectancy of 35 to 40

years according to figures from the graves at both Vedbæk and Skateholm. It also appears that members of the Skateholm society were victims to violent (Karsten 2004) and perhaps ritualistic behaviors (Larsson 1990). Indications of violence are observed particularly within the male individuals by a significant percentage of skulls which contain lesions apparently caused by the impact of an axe blow or a projectile point. This violence may have been the result of territoriality (Fisher 2002) possibly resulting from resource disputes such as fishing land-rights (Pedersen 1995). To argue territoriality, however, an accurate notion of population size and density must be included. While Larsson (1990) states that Scania's Ertebølle population would have numbered 2000-3000; others remind us that these figures come only from bio-mass to land mass ratio potential (Andersen 2002) or ethnographic and historical estimates (Karsten 2004) and do not consider existing regional and demographic elements.

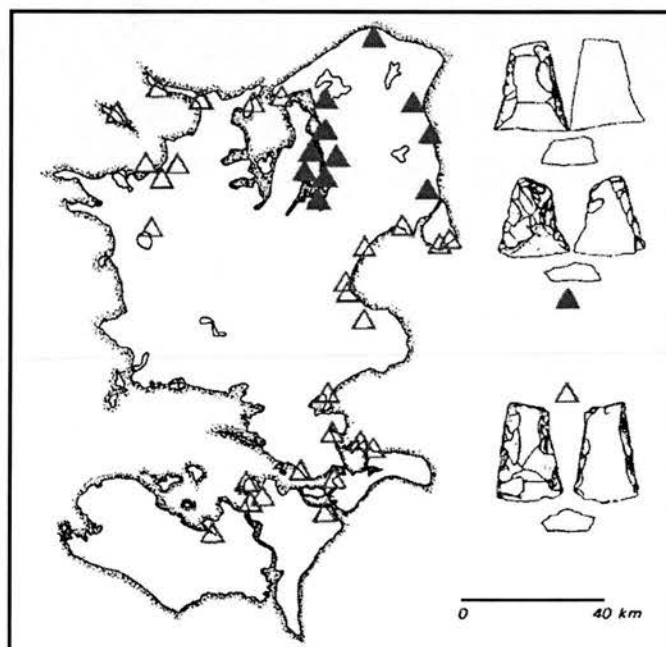


Figure 2.18 Distribution of axe types in the Danish isles (after Price 1991). Such variation has been suggested to imply sub-cultures during the Mesolithic as defined by regional variation.

Price (1991) has discussed population distribution zones in an attempt to further define cultural distinctions within the region of southern Scandinavia, an idea previously presented by Vang Petersen (1984). Rowley-Conwy (1998, 201) suggests that “local groups will adapt their behaviors to local conditions” and states that the inhabitants of Skateholm I “behaved the way they did for reasons entirely local and

temporary.” Larsson (1990, 294) appears to agree and assumes “that the process of change took different courses depending on the distance from the continent and depending on paleoecological conditions.” Larsson also suggests that southern Scandinavia was culturally divided into distinct territories: Jutland, the eastern Danish Islands, and Scania. Evidence from Zealand shows that further local divisions can be seen in Ertebølle, perhaps indicating variations between local groups (Price 1991; Karsten 2004).

## **2.4 Submerged Mesolithic Archaeology of Southern Scandinavia**

The following section describes the underwater archaeological sites from the Maglemose, Kongemose and Ertebølle cultural phases of southern Scandinavia. Multiphase sites and transitional sites are included and the selected sites are presented in a linear chronological order from oldest to youngest. The synthesis of underwater archaeological methodology and its application to sites in Denmark and southern Sweden is not presented as a comprehensive catalog of all underwater archaeological sites as the number of submerged prehistoric sites in the region is vast (fig. 2.1). Rather a collection of sites which best represent the cultural phases and those which have yielded the most archaeological informative materials through underwater archaeological methodology, is described herein.

### **2.4.1 Underwater Evidence from the Maglemose Culture**

Due to isostatic uplift in Norway and parts of Sweden some coastal Maglemose sites do exist above modern sea levels, while contemporary sites in Denmark lay underwater. During the mid 1980's, when the Småland Bight was subjected to intense survey, no coastal Maglemose sites from Denmark had been discovered (Fischer 1993) and it was thought that evidence from Norway and Sweden gave an accurate picture of site-type and distribution and this was related to Denmark and the southwest Baltic. Underwater archaeological evidence of the Maglemose culture has since been discovered.



## **Pilhagen, Svalerumpen & Kalø Vig**

Sea level rise broke the narrow land barrier, which separates Scania from modern Zealand c.7000 BC (Björck 1995, Karsten 2004). During the following 1000 years, sea level rose over 20m and the Øresund strait which thus formed, has not been particularly favorable for underwater Maglemose site preservation (Karsten 2004). This is primarily due to strong sea currents though in some exceptional cases, there have been Mesolithic finds, consisting mainly of flint and bone artifacts. The fishery presupposition model was useful for discovery of Maglemose sites after Pilhagen, near Landskrona, which was discovered in 8m depth. Two radiocarbon dates yielded results were calibrated to c.7000 BC (Fischer 1995). Additionally, Svalerumpen southeast of Copenhagen, was found at a depth of 6m. This classically Maglemose site was initially dated typologically based on the rich flint inventory, and was later calibrated to c.7200 BC (Fischer 1995).

A transitional Maglemose – Kongemose site at Kalø Vig, north eastern Jutland, was discovered between the depths of 4m to 8m. Triangular, narrow trapeze flints were discovered as well as hazelnut and antler remains which yielded a date of 6400 BC (Fischer, 1995). Based on typological identification of lithics material and the transitional date, this underwater site has been used as evidence of the transition between Maglemose and Kongemose cultural phases, as the radiocarbon determination mentioned was extracted from a pole from the permanent fishing structure (Fischer 2006). This is presently the oldest known fishing structure found in Denmark (Fischer 2006, tab. 2).

### **2.4.2 Underwater Evidence from the Kongemose Culture**

#### **Blak I & II**

Divided into two sites, the Blak project was originally conducted near the small island of Eskildsø in the Roskilde Fjord, was carried out by the *Egns Museet Færggården* and was lead by S. Sørensen. The early Kongemose sites, submerged

at 3-4m depth were typologically identified as a phase of transitional Maglemose-Kongemose cultural occupation (Sørensen 1996). In addition to presence of microliths and trapezes, the flint tools show limited impact of the transgression as they are not rounded, nor have they been dramatically affected by patination. Furthermore, human remains were recovered, including a mandible was discovered in a rubbish layer at Blak I. The transitional Blak phase has been suggested to represent the cultural transition from c.6600 – 6100 BC (Sørensen 1996) and is therefore significant in defining the earliest Kongesemose.

### Musholm Bay

In the mid and late 1980's, Danish surveyors set out to find submerged Kongemose sites (Fischer 1993) using the presupposition model for submerged sites. The impact of this underwater survey strategy on general knowledge of the Kongemose in southern Scandinavia is considerable and cannot be easily dismissed.

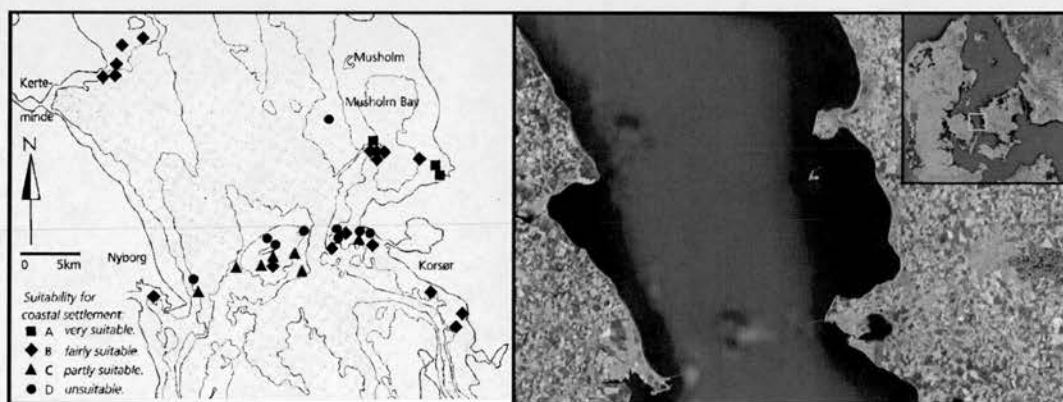


Figure 2.19 Musholm Bay and surrounding region: Suitability for coastal settlement (after Fischer 1997) Satellite imagery of the region shows Musholm bay just North of the small inlet Korsør Nor, which is discussed later in detail.

Musholm Bay is significant, not only because of its submerged forest, but because when discovered it was thought to possibly be the earliest evidence from the Kongemose material culture dated to 6400 BC (Fischer 1995). A crew of divers spent a total of 80 hours underwater examining an area 200m<sup>2</sup>. Test excavations were conducted and in total only 0.5% of the entire area yielded positive results.

Artifacts were primarily of flint, mainly waste flakes from the production of blades. The blades were manufactured by striking with an antler implement, and are thought to have been worked further into arrowheads, burins, and knives (Fischer 1997).

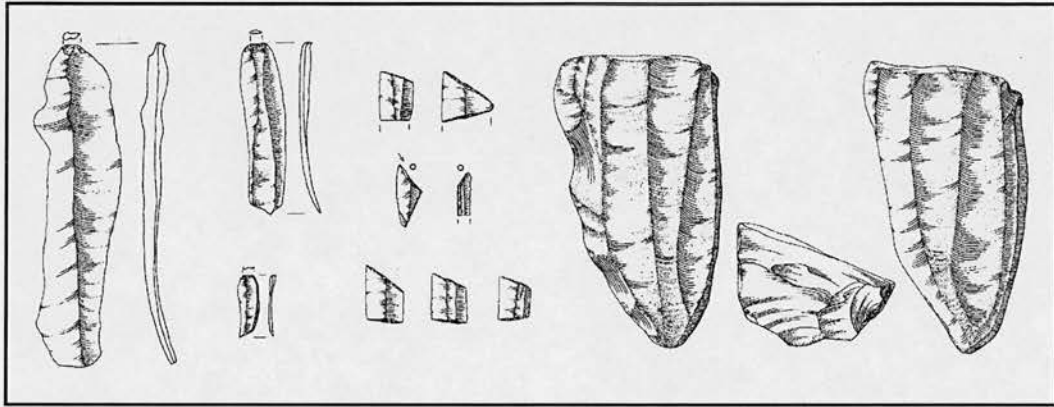


Figure 2.20 Selected blades, microliths, and cores from Musholm Bay (Fischer 1997) various scales.

Trapeze points from Musholm Bay (fig. 2.20) appear to be transitional in form given the assemblage, which shows both narrow trapezes associated with the Maglemose Culture and the rhombic arrowhead typical of the Kongemose culture. These finds help define what is one of the less known transitions in Danish prehistory (Fischer 1997).

### **Argus Bank**

Work began on the submerged site of Argus Bank in 1984 (Fischer 1993). This early Kongemose site from the Villingbæk phase measures 50m by 100m and contained classic flint implements, including rhombic shaped arrowheads made from micro burin technique, and large blades. The age of the site was determined by both typological dating, and consistent radiocarbon determinations from samples of human bone, and charcoal date Argus Bank to 5700 BC. Kongemose artifacts included flint, fish and animal bone, charcoal, wood and antler, and a hearth (Fischer 1993, 2004). The Argus site, in addition to its contribution to the archaeological record, was instrumental in establishing the successful model for presupposition of Stone Age fishery sites (Fischer 1993).

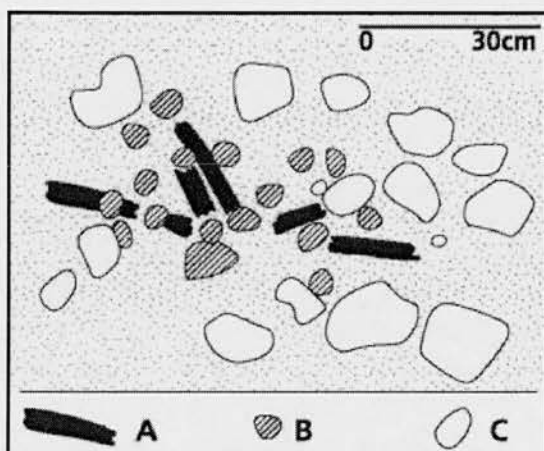


Figure 2.21 A diagram of a submerged hearth at Argus Bank: (A) Charred branches (B) burned flint (C) Stone pavement (after Fischer 2004).

### **Vigsø Skål, Malmgruden & Femø Skollerev**

The surveys of 1985-1986 resulted in positive site discovery at several locations, including Vigsø Skål and Malmgruden (Fischer 1993). The former, at 5m depth, was an arrowhead production site occupied during both the early and late Kongemose contained a hearth and yielded 282 flint artifacts. The latter, a Kongemose axe production site, also contained an adjacent hearth, and at 9.5m depth yielded 226 artifacts. Both sites were eventually dated both typologically and through radiocarbon determinations to the Kongemose occupation (Fischer 1993). Femø Skollerev was previously mentioned for its submerged prehistoric forest and a radiocarbon date from a preserved oak stump nearly 8000 years old (Fischer 1997b). Evidence from Femø Skollerev suggests that this site was occupied during the early Kongemose, and was transgressed during the Ertebølle.

### **Transitional Kongemose-Ertebølle: Vedbæk & Korsør Nor**

During this transitional period, which directly preceded the Ertebølle, thicker blades were produced and the end of microblade technology was signaled in southern Scandinavian Mesolithic (Christensen 1995). An increasingly stationary middle Mesolithic population eventually transitioned into a fully sedentary culture at the



beginning of the Ertebølle. “In Scania the classical lifestyle as hunter-gatherers therefore came to an end with the end of the Kongemose culture around 5600 BC” (Karsten 2004, 142). Refuse layers were rich in terrestrial organic material and a series of radiocarbon dates indicated phases of the Kongemose and Ertebølle represented at Vedbæk (Christensen 1995). The use of terrestrial organic material eliminates any additional calibration to compensate for a marine reservoir effect.

Archaeological material found at Korsør Nor, an inlet on the Storebælt just south of Musholm bay, was discovered in the 1940’s. The date of 5400 BC at Korsør Nor comes from a jawbone of a middle aged male from the Kongemose occupation (Bennike 1997). Remains of bark layers have been detected in at least two of the graves found at the cemetery of Bøgebakken in Vedbæk (Schilling 1997). In the case of the Korsør Nor graves however, only indirect evidence exists to support a Kongemose burial including bark structures. The well preserved evidence from the Ertebølle at Vedbæk has suggested that bark was used to make a coffin-like feature.

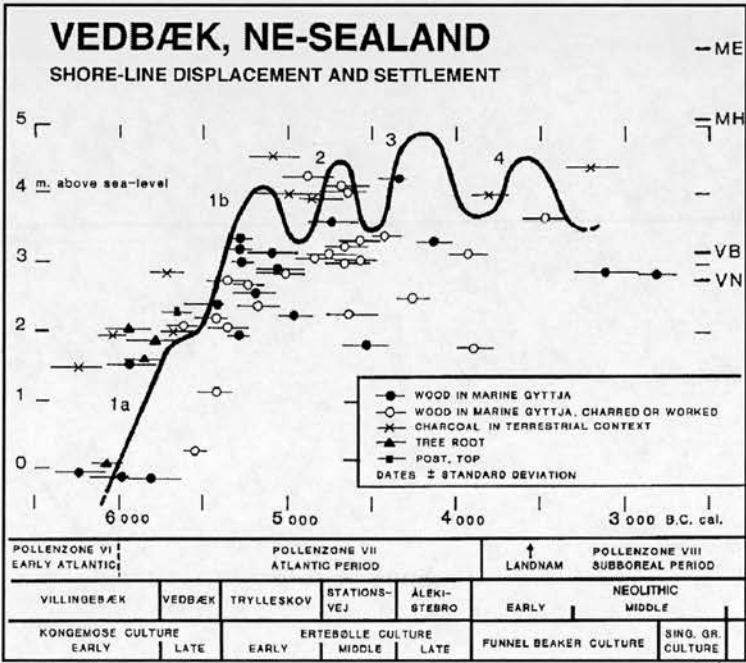


Figure 2.22 Shore-line displacement curve for Vedbæk Fjord as compared to present sea level (after Christensen 1995).

Over a dozen sites have been discovered at the Korsør inlet and the primary site (referred to as 'Korsør Nor') is defined by its Ertebølle burial and is the most renowned. The quality of preservation of human remains, evidence of burial rites, health, subsistence, and social elements have been documented by the Korsør Nor site which dates from 5500 BC to 4500 BC (Bennike 1997; Schilling 1997). While the majority of finds from Korsør Nor date from the early Ertebølle, the site is also dated typologically through retouched stone, bone and antler tools, which suggest evidence of late Kongemose occupation (Schilling 1997). Kongemose artifacts include scrapers and axes of flint and a bone dagger. <sup>14</sup>C dates from two individuals give early Ertebølle dates of 5400 BC and 4900 BC.



Figure 2.23 The Korsør Nor Skeleton as housed in the National Museum, Copenhagen (photo by author).

The best preserved grave from the Korsør Nor site is that of an adult male wrapped in bark (fig. 2.23). A single blade knife was the only grave good found alongside the individual (Schilling 1997). It has been argued that this burial practice may have been similar to the logboat burial of Møllegabet (discussed later in detail). This theory was rendered implausible by Shilling who suggests that the positioning of the

bark both over and under the individual, as well as the existence of stakes and a transverse rod that may be interpreted as a Mesolithic burial shroud or a coffin. Shilling suggests that the stakes represent a kind of wooden frame for the burial structure.

Positioned in a narrow strait at the entrance of the inlet, the site was deliberately chosen for its favorable location for passive fishing (Fischer 1993). The individual, a male between 30-50 years of age; is described as sturdy, and muscular, and is estimated to have been 168cm tall (Bennike 1997). It appears that, based on  $^{13}\text{C}$  analysis, three quarters of the inhabitant's food came from the sea. Although no fish remains exist at Korsør Nor, evidence for logboats in planks of flattened wood, which would have been used both for fishing and perhaps longer journeys, were recovered (Schilling 1997). Additionally, trade to Jutland is implied by the presence of a dagger made from Elk bone, a species not found in Zealand, but that was in existence in Jutland at the time.<sup>39</sup>

### **2.4.3 Underwater Evidence from the Ertebølle Culture**

#### **Early Ertebølle: Magrethes Næs & Møllegabet II**

At a depth of 1.5m, the submerged site of Magrethes Næs, in the Halsskov Fjord, was excavated in 1989 (Myrhøj & Willemoes 1997). Over a period of 700 years this area was occupied by the later Kongemose and early Ertebølle cultures. Wreckage of three dugout canoes and fishing equipment were recovered, the oldest of which was dated to 5440 BC (Christensen 1997, tab. 1), making this amongst the oldest examples in southern Scandinavia. Sealed in silt, these finds were originally deposited, and abandoned in a creek. Additionally, a heart-shaped blade of an oar, made of aspen, was dated to around 4770 BC. The wooden paddles, unlike those found at Tybrind Vig (fig. 2.31; S.H. Andersen 1987), are found undecorated. Both canoes from the creek were made of limewood, and the younger boat was dated to

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<sup>39</sup> Shilling cites Aaris-Sørensen (1988) in his discussion of Elk species in Jutland.

5060 BC (Myrhøj & Willemoes 1997). A flint axe head, likely used for boat construction, was also discovered, as was evidence from a fish weir. Notably, the size and type of material from the fishing structure, dated to 5060 – 4790 BC (Fischer 2006, tab. 2) does not seem to differ greatly from later Neolithic structures found at Oleslyst (Myrhøj & Willemoes 1997). This evidence can be used to argue Mesolithic social complexity for forest management as well as Mesolithic-Neolithic cultural continuity (Fischer 2002, 2006).

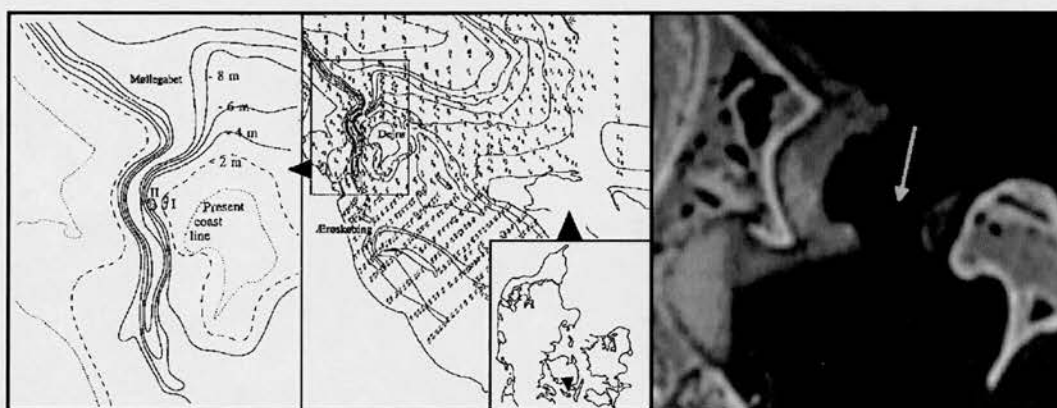


Figure 2.24 Møllegabet I & II, underwater sites, Æro, Denmark (adapted from Grøn & Skaarup 1991). Satellite Image of the position of the sites in the small strait.

South of Funen, to the North of the island of Æro, the underwater sites of Møllegabet provide both classic data from the earliest Ertebølle, as well as unique and surprising evidence from this period (Grøn & Skaarup 1991; Skaarup 1995). At a depth of 4.5m, Møllegabet II has been associated with the earliest Ertebølle culture. Radiocarbon dates of c.6800 BP are 1000 years older than neighboring site Møllegabet I, less than 30m away. As expected, evidence from Møllegabet II shows that fish composed the mainstay of the inhabitant's diet. Cod made up 95% of the fish bones, eel bones are nearly absent although this is a misrepresentation as a result of poor preservation (Grøn & Skaarup 1991; Skaarup 1995). Significantly, Møllegabet II yielded the discovery of Denmark's first underwater Mesolithic hut (Grøn & Skaarup 1991; Grøn 2003). The floor of the dwelling recessed by up to 20cm and was composed of bark, twigs, and bracken leaves (*Pteridium aquilinum*), was rectangular in shape, measured 5.2m by 3.2m, and contained a hearth (Grøn 2003).



Cultural material from Møllegabet includes worked flint, fish bones, shells and nuts both within and without the enclosure. Additionally, and significantly, was the discovery of the submerged burial site of an adult male, age 25 years, who appears to have been buried at sea (Grøn & Skaarup 1991; Skaarup 1995). The man was originally adhered to the boat, and his body was wrapped in elm bark before the limewood canoe was sunk near the site. This burial is unique in Mesolithic archaeology, however this type of mortuary rite is supported by ethnographic evidence and later prehistoric evidence. The Møllegabet II boat burial is accompanied by a small cemetery nearby on land (Grøn & Skaarup 1991).

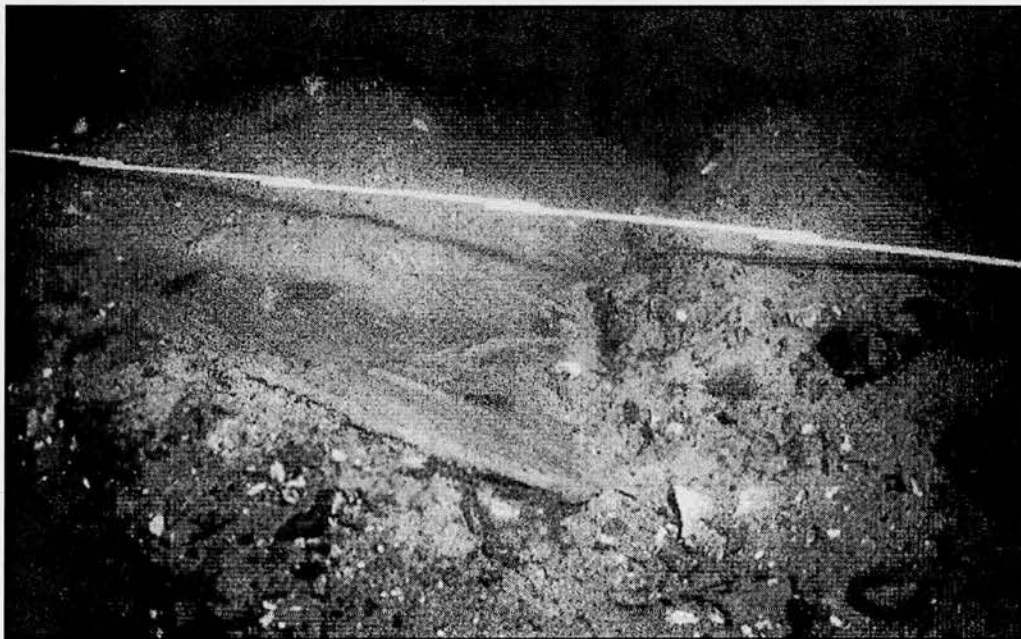


Figure 2.25 Photo of the boat at Møllegabet II immediately after its discovery (Grøn & Skaarup 1991).

### **The submerged Middle Ertebølle: Lindholm I (Nyborg Fjord)**

Transverse arrowheads, greenstone, pottery, bone, antler and wood were found at Lindholm I. Bone points, awls, and flaking tools, as well as an antler shaft and dagger made from a wild pig's ulna were excavated (Dencker 1997). In addition, wooden objects, including the remains of two longboats were recovered. The logboat

was made of limewood and had traces of charring (Christensen 1997). Two wooden paddles were also recovered (Christensen 1997; Dencker 1997). Dencker also discusses a wooden stick, which he suggests was used to dig for roots or grubs, identified through use-wear analysis. Despite its preservation, the 117cm worked stake of hazel does not seem a complex or particularly informative artifact; it has not appear to have been part of a composite tool, nor has its implied use been confirmed. Dates from pollen, and the 'digging stick', as well as typological dating of the flint points indicate Lindholm I to be from approximately 4570 BC (Dencker 1997), part of the middle Ertebølle cultural phase.

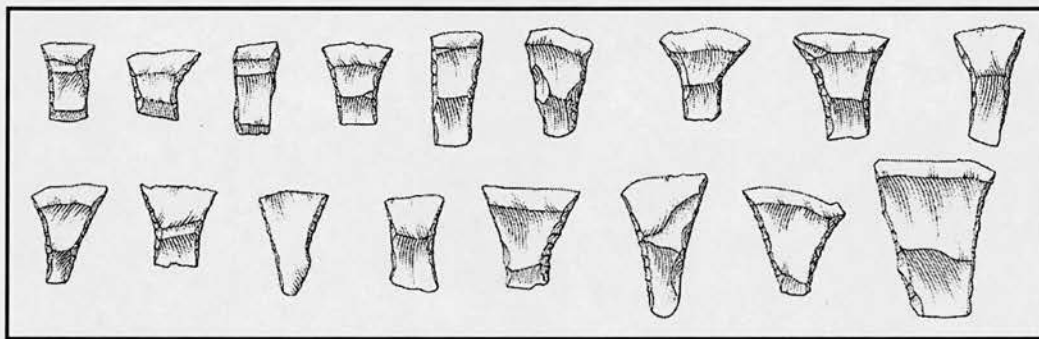


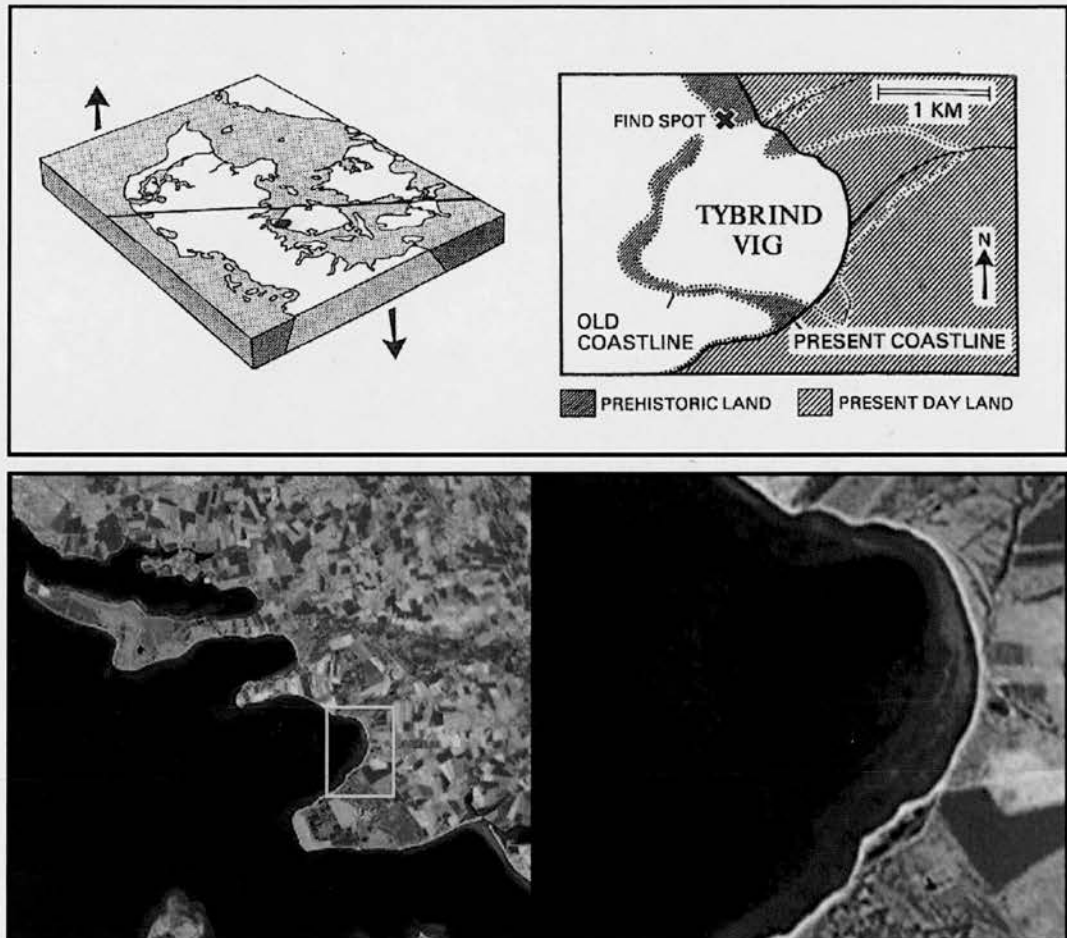
Figure 2.26 Transverse Arrowheads from Lindholm I (Dencker 1997) without scale.

### **The submerged Late Ertebølle: Møllegabet I**

The submerged site Møllegabet I (fig. 2.21) was discovered at 2.3m depth. The late Ertebølle site, exhibiting a shell midden 60m long by 0.7m thick was discovered preserved in a gyttja layer (Skaarup 1995). Numerous faunal remains were discovered, including extensive marine mammal remains of seals, porpoises and even a full sized whale. Flint tools and pot sherds from pointed base pottery and blubber lamps were also recovered (e.g. Thorpe 1996, fig. 4.1). Well-preserved organic remains, such as wooden leister prongs are the classic endorsement for underwater archaeological data, as a composite fishing spear, hafted, and intact, show exactly how these fishing devices were made (Skaarup 1995). Wood remains from the construction of a canoe were also recovered. Skaarup suggests that some of the human remains recovered from Møllegabet I include evidence of cannibalism;

split bones have been suggested to be evidence of marrow extraction. This however, remains speculation as split bones alone cannot be seen as conclusive evidence for cannibalism.

### The submerged multiple occupation Ertebølle site: Tybrind Vig



Figures 2.27 (above) Tybrind Vig in relation to the 'tilt line' and present versus paleocoastlines (S.H. Andersen 1987). (below) Satellite imagery of Tybrind Vig.

Perhaps the most famous of all underwater archaeological sites from Mesolithic Scandinavia is Tybrind Vig. Located 300m off the modern west coast of Funen (fig. 2.27), Tybrind Vig is a submerged Ertebølle settlement, excavated from 1978-1988 (Malm 1995). Over the ten years of experimentation off the coast of Funen, expensive and time-consuming excavation eventually yielded successful results. While Ertebølle fishing practice is well documented, "no other sites are, however so

well furnished with indicators of exploitation of the marine element.” (Malm 1995, 391). More than 10 fish hooks made from red deer bone have been recovered, including one completely preserved, with the line attached. Fish traps, and marine animal remains have also been recovered (S.H. Andersen 1985; Malm 1995). The fishing equipment from Tybrind Vig has been used as evidence for territoriality, and the importance of landscape and fishing rights.

Sand and gravel deposits contain well preserved artifacts because of the gyttja layers caused, in the case of Tybrind Vig, by the enzymes in the dominant species of Eelgrass (*Zostera marina*) which is the most widespread angiosperm in the Danish coastal waters (T. Christensen *et al.* 2004). It is this organic preservation that is prized by archaeologists at underwater sites, and in this case, resulted in the discovery of these ancient woven textile (fig. 2.28) recovered at Tybrind Vig (S.H. Andersen 1985). The Z-spun plant fibers knotted in needle netting technique survived the six millennia, because of the anaerobic, cold conditions.

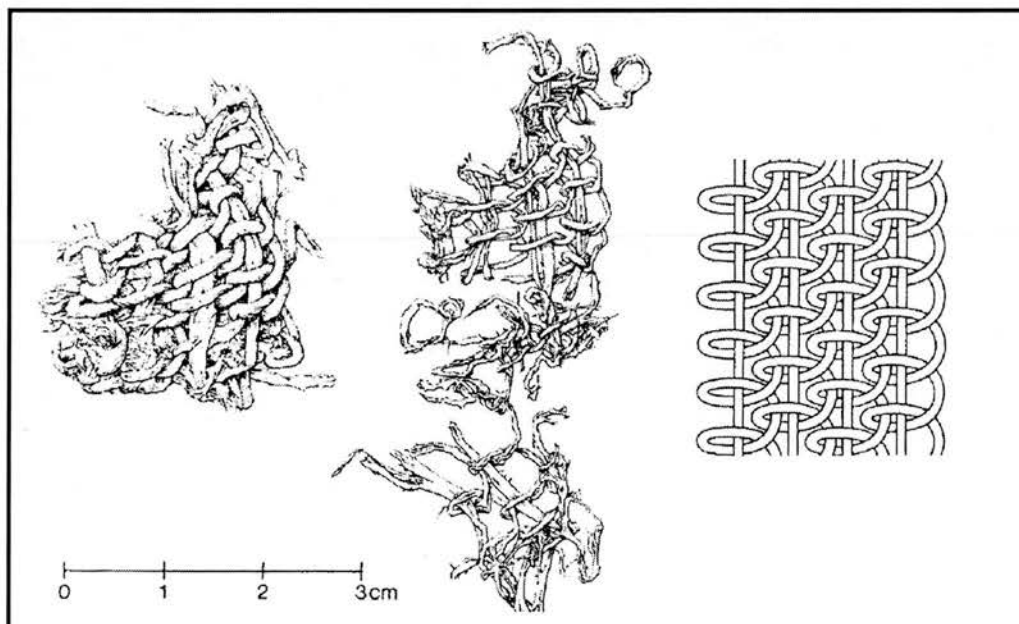


Figure 2.28 Textiles from Tybrind Vig: Z-spun plant fibers show needle-netting technique (after S.H. Andersen 1985).

Marine watercraft, are represented at Tybrind Vig by three logboats, which show a variation in the size of boats in use during the late Mesolithic. The dugout watercraft



measured approximately 9m, 5m, and 3m in length. The longest of these boats appears to have been sunk with a ballast stone *in situ* (S.H. Andersen 1987). While there were no skeletal remains found in the boat to imply burial at sea, human remains have been found elsewhere at Tybrind Vig. A well preserved grave of woman and child has been excavated, and radiocarbon determinations have dated these skeletons to c.6440 BP, the earliest Ertebølle period.

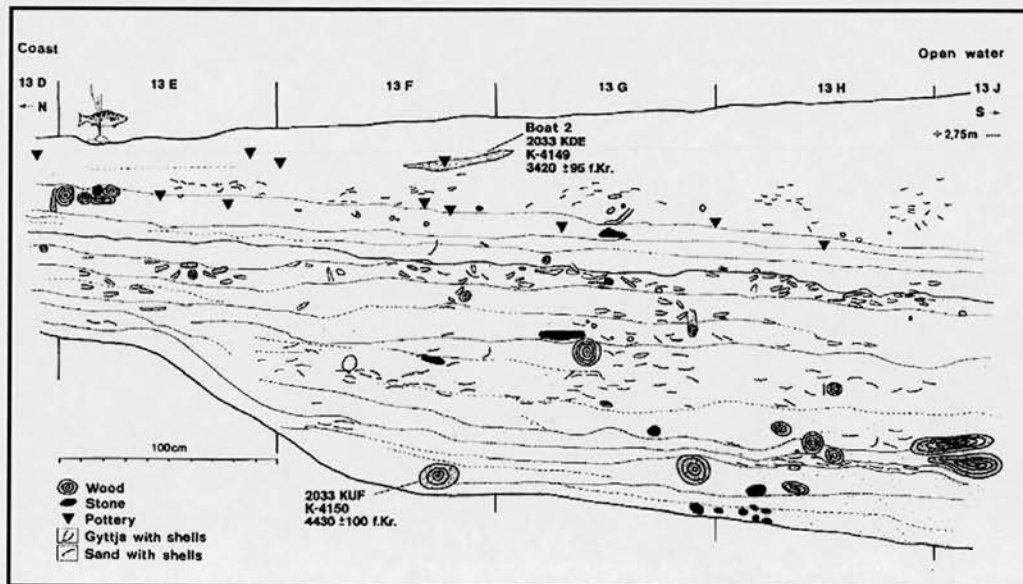


Figure 2.29 Cross-section from Tybrind Vig including 'Boat 2' (after S.H. Andersen 1985).

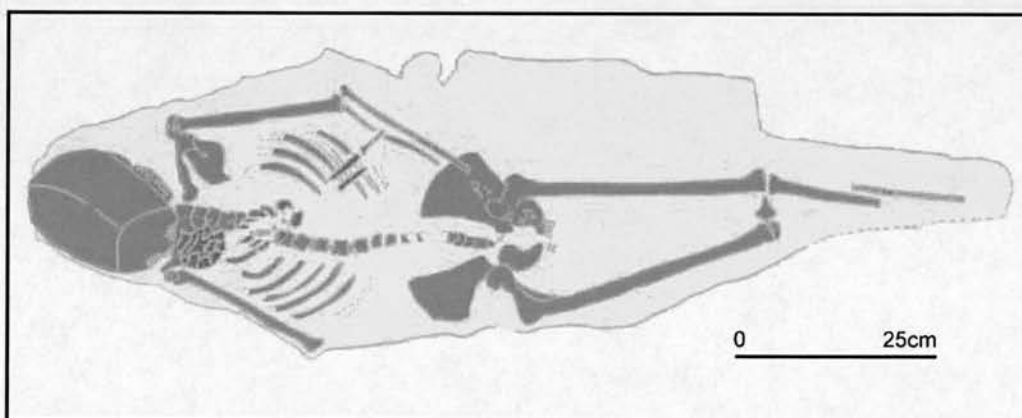


Figure 2.30 Sketch of the a burial of a woman (red) and her child (blue), from Tybrind Vig (after S.H. Andersen 1985; as published in Fischer 2004).<sup>40</sup>

<sup>40</sup> Although Fischer (2004) cites Smed (1987) for this image, the original black and white diagram of this burial at Tybrind Vig was published in S.H. Andersen (1985, fig 6).

Tybrind Vig is perhaps most well known for the presence of four ornamented paddles (S.H. Andersen 1987). These paddles are the oldest ornamented wooden objects from the Danish Mesolithic and were the first finds of this kind. The ornamentation has been interpreted as decorative in function, although they may have also served a practical purpose; perhaps they were used as identification the way a flag is used on a modern boat. It has been suggested that territorial or familial connections may have been expressed through such decoration (Myrhøj & Willemoes 1997), however this claim remains unsubstantiated by direct evidence.

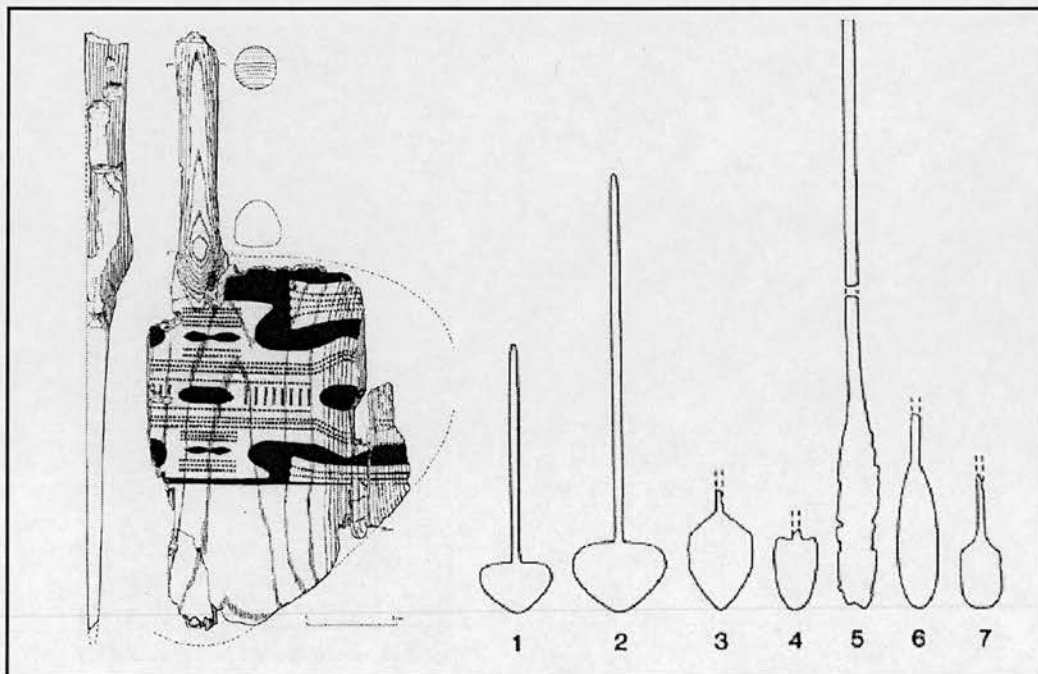


Figure 2.31 (left) A decorated paddle from Tybrind Vig (right) Schematic reproduction of Ertebølle paddles from southern Scandinavia. Examples 1 & 2 are from Tybrind Vig (adapted from S.H. Andersen 1985, 1987).

Although many fantastic finds have been discovered at Tybrind Vig, the site has not been perfectly preserved and has endured glacial deposits and sea transgressions (Malm 1995), which are disturbances to sites under most circumstances. As discussed in the previous chapter, these processes can have both positive and adverse effect, simultaneously disturbing elements of the site, while preserving some of the material. While Malm calculates the costs of excavation at Tybrind Vig over a ten year period are anywhere from five to ten times the price of traditional land

archaeology, the results are incredibly well-preserved artifacts from the Mesolithic. This evidence is unique to the archaeological record, yet the existence of such material during the Mesolithic must surely have been present throughout southern Scandinavia. Archaeologists are afforded these details solely as a result of the preservation afforded by the submerged, anaerobic conditions and underwater archaeological methodology.

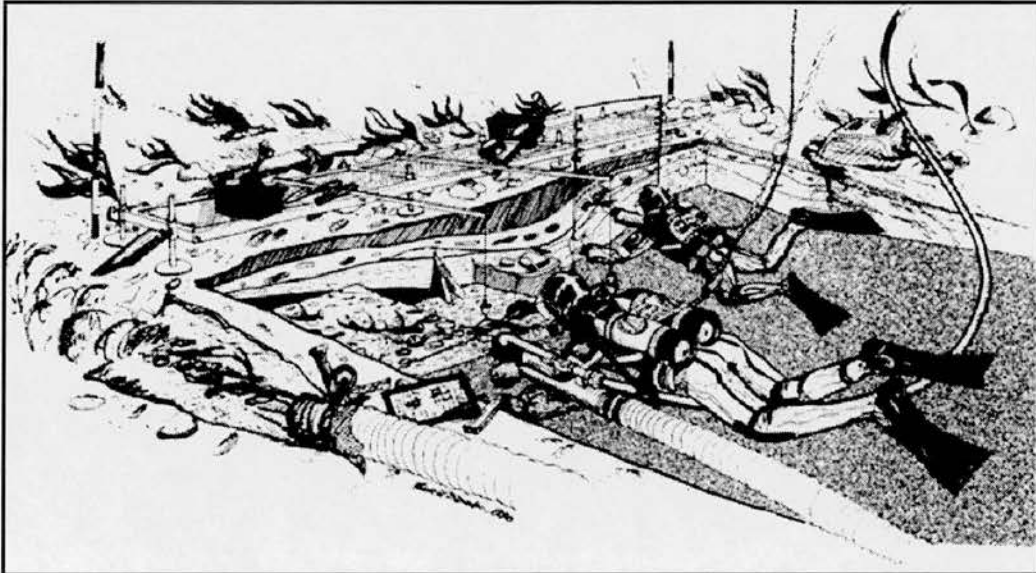


Figure 2.32. Excavating at Tybrind Vig (after Malm 1995). Excavators use a water dredge. A frame placed on the seabed holds a Plexiglas panel, used to document stratigraphy. Currents are visibly originating behind the divers, while a mesh bag collects small material.

## 2.5 Underwater Mesolithic-Neolithic Sites of the German Baltic

While it is assumed that Neolithic culture came from neighboring areas of the southern Baltic, it is difficult to identify an exact origin of the early Neolithic in the region (Fischer 2002). Wangels, in eastern Holstein to the west of Mecklenburg Bay, has recently produced a date from the early TRB which is 100 years older than that of any artifact in Denmark (Fischer 1995), and a variety of lithic, bone, and ceramic evidence has been recovered from this rich site (Hartz 1998; Lübke *et al.* 2000). Hartz & Lübke (2006) have proposed that the Wangels phase 4100 BC – 3800 BC constitutes the earliest Neolithic in the region, and suggests that “antler, bone and wooden implements of this phase show a significant similarity” to earlier Mesolithic

sites in the Mecklenburg region while also possessing tools and ceramic material consistent with Funnel Beaker culture (p. 66). The community living at the underwater site at Wangels, possibly under the influence of expanding Neolithic farming communities, began practicing agriculture by 4200 BC (Lübke *et al.* 2000); it is believed that this influence came from the immediate vicinity to the southwest.

Agriculture may have been established on the lower Odor estuary as early as 5200 BC, although reliable dates show this to be between 4800 - 4600 BC (Fischer 2002). Pollen and domesticated cattle from Rosenhof yielded ages of 4700 BC while dates from submerged sites along the German Baltic may suggest Ertebølle occupation to as late as 4100 BC (Lübke 2002; Hartz & Lübke 2006). Lübke maintains that dates from over 50 known sites of the northern most region of Germany have given a detailed picture of the cultural phases and Neolithic process from the southern Baltic coast (Lübke *et al.* 2000). Despite this, Fischer suggests that some of the dates from the coast of the northern Germany, particularly from the Odor, are not reliable (Fischer 2002) and are too young. Nevertheless, sites from the German Baltic are of direct relevance to Denmark and southern Sweden, and underwater evidence has impacted the archaeological record and debates. In northern Germany, underwater archaeological sites containing Mesolithic and Neolithic material are found mainly near Mecklenburg Bay (Lübke *et al.* 2000; Hartz & Lübke 2006) and on the Island of Rügen (Lübke *et al.* 2000, 2002; Lübke & Terberger 2002). The site of Drigge on Rügen has produced human remains dated to c.5200 BC and bone and antler remains to c.5000 BC (Lübke & Terberger 2002), and while they were found at 5m below sea level, they were excavated accidentally by industrial dredge, and thus provide no associated contextual information. "Four dates from Parow obtained on charred food remains from early Neolithic ceramics with a cluster of dates from about 4,000 to 3,900 BC point to a beginning of the Neolithic period in Rügen before 4000 BC... Parow is the most important complex of the earliest Neolithic..." (Lübke & Terberger 2002, 51). This is based on the early dates and the evidence of early Neolithic subsistence strategy. In total seven Mesolithic and Neolithic coastal sites from Rügen been dated through radiocarbon determinations (Lübke & Terberger 2002, tab. 1).



Coastal sites from the Mecklenburg and Rügen areas not only contribute to the material cultural record, but seem to fit the presupposition model for submerged sites based on their geographic orientation (fig. 2.33; Lübke & Terberger 2002, fig. 1). Several sites located in close proximity to narrowing areas of inlets and along straits, seem to form the norm for this region (Lübke *et al.* 2000). Dietary evidence extracted from an individual at the terrestrial site at Schonen indicates a mainly terrestrial diet, supplemented by marine foods. At the underwater site of Käggsdorf, archaeologists recovered a Neolithic human skull fragment, which, more predictably, showed a decrease in marine resources in this Neolithic individual's diet (Lübke *et al.* 2000).

### **Wismar Bay**

Information on submarine Stone Age settlements comes from a variety of sites from Wismar Bay, on the German Baltic coast (Lübke 2002, 2003; Hartz & Lübke 2006). Similar to southern Scandinavia, submerged forests have been used to formulate sea level change curves in this region (Lübke 2002), and comprehensive geographical reconstructions of the region have been presented (Schmölcke *et al.* 2006, figs. 2,4) representing the region from 8800 – 4000 BC. Sites and finds from this coastal region contribute to the debate for the age of Neolithization in the Baltic and southern Scandinavian regions (Fischer 2002; Lübke 2002; Hartz & Lübke 2006). The earliest archaeological material from the German Baltic comes from Jäckelberg in waters between 7m – 11m dated to c.5850 BC (Hartz & Lübke 2006, fig. 3). AMS dates from Timmendorf-Nordmole have been used to show the latest cases of the Ertebølle on the northern German Baltic coast dating to 4500 – 4100 BC. Wooden posts and animal bones including boar and red deer from Jäckelberg-Nord, as well as ceramics, bones, and wood from Timmendorf-Nordmole, and domesticated cattle bones from Timmendorf-Tonnenhaken have been used to establish the Neolithic process along the German Baltic (Lübke 2002). Furthermore, early finds from Jäckelberg-Nord indicate an early Ertebølle cultural presence in the region dated to 5600 – 5100 BC (Lübke 2002, fig. 4; Hartz & Lübke 2006, fig. 3).

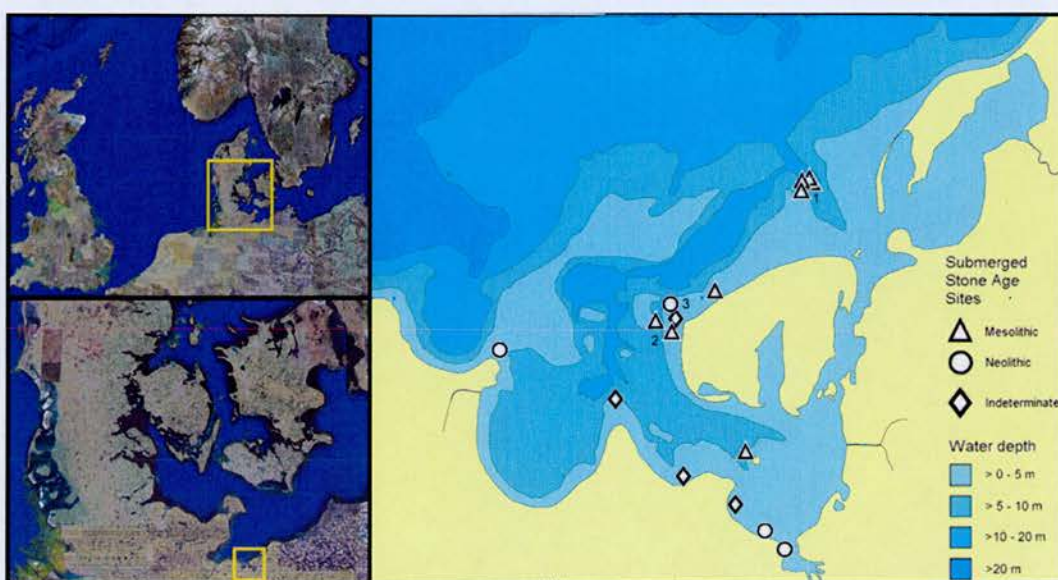


Figure 2.33 Submerged Mesolithic and Neolithic sites from Wismar Bay, northern Germany (after Lübke 2002).

Tools recovered from Timmendorf-Nordmole include wooden implements such as leister prongs, wooden shafts, and a paddle (Lübke 2001; 2003). Over 100 wooden leister prongs have been recovered from the site (Lübke, pers. com.) and wooden spears are believed to have been used specifically to hunt eel (Lübke 2001).

Additionally, numerous implements of flint, antler and ceramic have been found in relatively good preservation. Investigations in this region commenced in 1998 (Lübke 2002), and continue to provide information about the Mesolithic and early Neolithic groups of northern Europe. Lübke argues that available radiocarbon dates indicate that the Funnel Beaker Culture appears to have replaced the Ertebølle no earlier than 4100 BC in the region (Lübke 2003).

During the 2001 season at Timmendorf-Nordmole, a truncated blade associated with the late Ertebølle was discovered (fig. 2.34). The remarkable find was discovered in an in-filled pit (Lübke 2001). The blade was found in a middle quadrant of the lower area of the pit-fill, the ventral side oriented upwards, lying flat, embedded in a sandy clay sediment with organic remains, and heavily coated with sand. Lübke asserts that it must have been disposed with the material used to fill the pit and is assumed to

have been lost, not purposefully deposited; because of the way in which the flint was oriented it was not immediately recognized. The negative imprint of the blade was perfectly preserved in the marl sediment, the actual blade could be retrieved later and reunited with its haft. The sediment, which encrusted the organic material of the haft was carefully removed with little damage to the artifact.

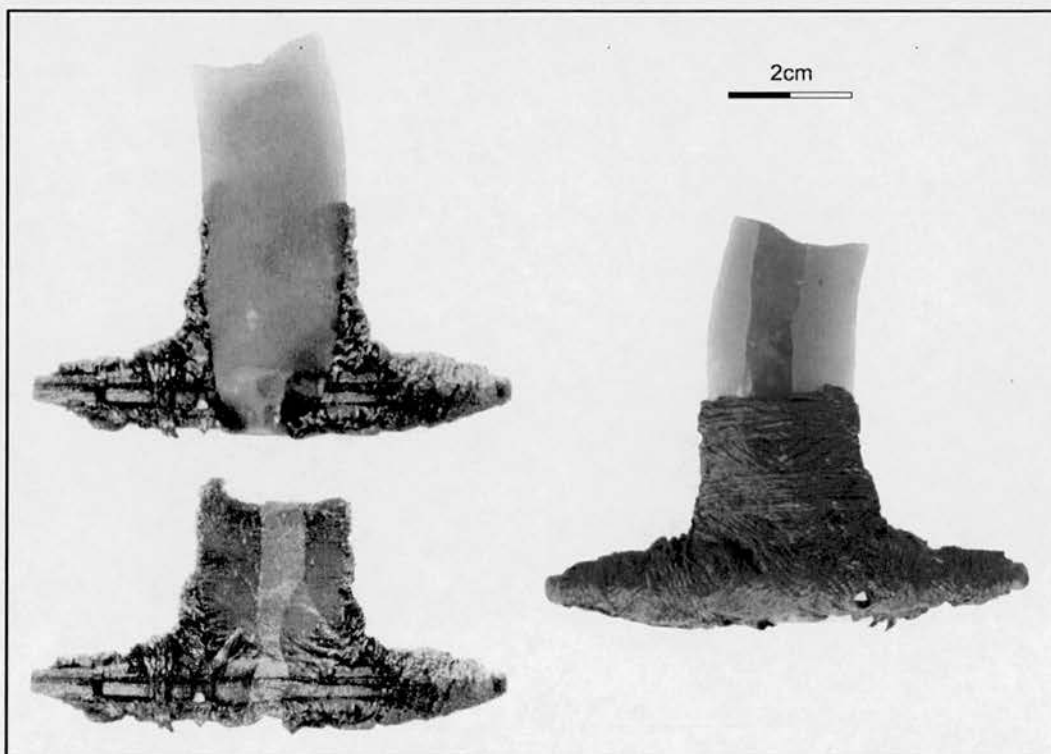


Figure 2.34 The hafted Ertebølle implement found at Timmendorf-Nordmole, Germany (Lübke 2001). The image on the right has been cleaned of encrusted sediment, revealing the details of the bast fibers.

The blade, made from a locally available flint, is 6mm in length and exhibits staggered retouch on both sides, indicating a deliberate dulling for the purpose of hafting. It was later analyzed and the preserved hafting is found to consist of hazelwood and be bound by lime baste (Lübke 2002). The blade is wrapped at 38mm so that, at the distal end, only 30 mm are exposed from the haft, as a functioning end. The hafting itself is composed of a wooden cross grip, fixed by baste wrapping of at least 6 fibers (Lübke 2001). The hafted Mesolithic blade, an extremely rare and important find, offers new information as the first such lithic to be discovered with a preserved haft. Associated radio carbon dates from upper layers



of the pit have come from a tibia of a dog dated to 4450 BC (5621±29 BP, KIA-8444) and burned food remains from 4160 BC (5335±29 BP, KIA-8447) (Lübke 2001; 2002).

## **2.6 The Early Neolithic TRB Culture of Southern Scandinavia 4000 – 2900 BC**

The Ertebølle has traditionally been defined through ceramic typology of smoothly profiled beakers with pointed bases and ceramic lamps, while later TRB (from the German word *Trichterbecher* meaning ‘Funnel beaker’) culture was defined by funnel beakers, lugged beakers, bowls, jars and baking plates (Fischer 2002). The Neolithization of Denmark has historically been argued to have occurred as a transitional event from either an ecological diffusionist model, or a migration model (Larsson 1990; Fischer 2002).<sup>41</sup> Recent discussions, however, have favored the socio-economic model, introduced in the 1980’s (Fischer 2002). Most aspects of the commonly defined ‘Neolithic life’ were well-established before agriculture was adopted as the principal subsistence economy. The Neolithization of southern Scandinavia was the result of a cultural transition of long-term progress and adaptation; these developments were caused both by ecological and demographic pressures, as well as influence, both culturally and technologically, from nearby regions (Larsson 1990; Andersen 2002; Fischer 2002). “The transition to agriculture in southern Scandinavia was thus the product of a shift in thinking rather than an economic development, for with it came the whole paraphernalia of the TRB Neolithic” (Thorpe 1996, 93).

Underwater archaeological evidence from the Neolithic is composed mainly of fishing installations (Pedersen 1997; Fischer 2006), which noticeably increased in size from the Mesolithic fishing structures. Neolithic material interpreted as deliberate, votive offerings (fig 2.36) have also been recorded in Danish coastal waters (Fischer 2004). Lübke has also recorded Neolithic sites in shallow waters less

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<sup>41</sup> A more detailed discussion of the general discussions and theories surrounding the Neolithization of Europe is found in the following chapter, and is related to the Mesolithic and early Neolithic of the eastern Adriatic, and western Slovenia.



than 5m depth in Northern Germany (fig. 2.33). Finally, through further defining the population expansion and the demographic debates associated with the late Mesolithic, underwater survey has helped to clarify the Neolithization process (Fischer 2002), as will be discussed further in detail.

## **Domestication**

Southern Baltic neighbors in what is now modern Germany (e.g. Hartz & Lübke 2006) and Poland (e.g. Bogucki 1998) practiced agriculture prior to the introduction of domesticates to southern Scandinavia. This was not a secret to the Mesolithic fisher-hunters as “contact with farmers preceded actual cultivation and herding by at least 500 years” (Price 1991, 17). Fischer identifies the oldest faunal evidence, unquestionably that of domesticated animals, as cattle bones from the Åmose settlement which have been AMS dated to c.3960 BC. An additional and more recent piece of data extracted from a single caprine specimen has yielded a similar date. Early typologically dated vessels with grain impressions from domesticated crops appear to be of the Funnel Beaker, Type I variety. Absolute ages from such impressions come from Muldbjerg I and Varby, and provide dates of c.3700 BC (Fischer 2002). Pollen data shows limited cereal cultivation during the period from 3600 – 3500 BC. When agriculture is introduced in southern Scandinavia “it appears to take hold remarkably quickly” (Thorpe 1996, 87) although slash-and-burn agriculture does not appear to have been practiced until after 3600 BC (Fischer 2002). Consequently, it is argued that though domestication was introduced with the first funnel beaker pottery, the people of the early Neolithic continued to pursue their ways as fishermen and shellfish harvesters. Evidence from large Neolithic fishing installations is used as proof of this continued relationship with the sea, and marine resources (Fischer 2002, 2006).

## **Fishing in the early Neolithic**

At the previously cited land site Oleslyst, near Halsskov, a fishing structure 40m long and 1.75m high was preserved and yielded an initial <sup>14</sup>C date placed the site at

3220 BC (4535±65 BP) (Pedersen 1995). A later radiocarbon date determined the earliest date at Oleslyst to be 3410 BC (4620±70 BP, K-6436) (Pedersen 1997; Fischer 2006). Eventually, a total of 10 radiocarbon dates established this structure's age to be between 3500 – 3100 BC, during the Funnel Beaker Culture (Fischer 2006, tab. 2). Further examination of the stakes from Oleslyst show that there were at least two structures present constructed several centuries apart (K. Christensen 1997). The structures serve as an important reminder of the importance of fjord fishery to Neolithic subsistence, even after the introduction of agriculture (Pedersen 1995, 1997).

Wattling technique and joining of panels are clearly visible as a result of conditions of preservation. There does not seem to be any lashing, based on a lack of both marks or remains of twine. Hazel material, however, seems to have survived within the archaeological record better than lime, which is often poorly preserved. Construction of the horizontals is indicated through axe marks (Pedersen 1997). Traps, known to have existed at the end of the fish fences, are not often found. This is the case at Oleslyst and Halsskov. It is probable that these removable features would have been removed from the water, perhaps for the winter, which would explain their frequent absence in the archaeological record (K. Christensen 1997). Oleslyst & Halsskov are not the only sites, which yield fishing structures from the Neolithic. Ølby Lyng, Oreby Rende, Smakkerup Huse, Sankt Klaravej Nøddekonge all contained evidence of fishing installations dating from the Neolithic as early as 3980 – 3790 BC at Nøddekonge to 2900 – 2350 BC at Ølby Lyng (Fischer 2006, tab. 2).

Built of large quantities of wood from local forests, fishing structures are of particular importance to the TRB culture of southern Scandinavia. Measuring no less than 200m long and up to 5m high, the weir at Nesklø would have supplied more fish than the occupants of the island could have eaten. "Since it was rebuilt many times in the period c.3500 to 3100 BC it may be taken as an indication of the existence of a stable system of redistribution of food among occupationally specialized groups inhabiting this island and neighboring parts of Zealand" (Fischer

2002, 384). Isostatic uplift has moved the fishing structures at Neskøl, and while during the early Neolithic they would originally have reached depths to 4m to 5m below sea level, evidence of such installations is found both underwater and above sea level (Fischer 2006). The wooden material found underwater at Neksøl is “generally well preserved, including their bark cover. In one case it was observed that the inner-bark of a vertical pole still had its original bright green color when it was dug out of the sea floor. However, its fresh look vanished quickly as soon as it came up into the oxygen-rich sea water” (Fischer 2006, 5).

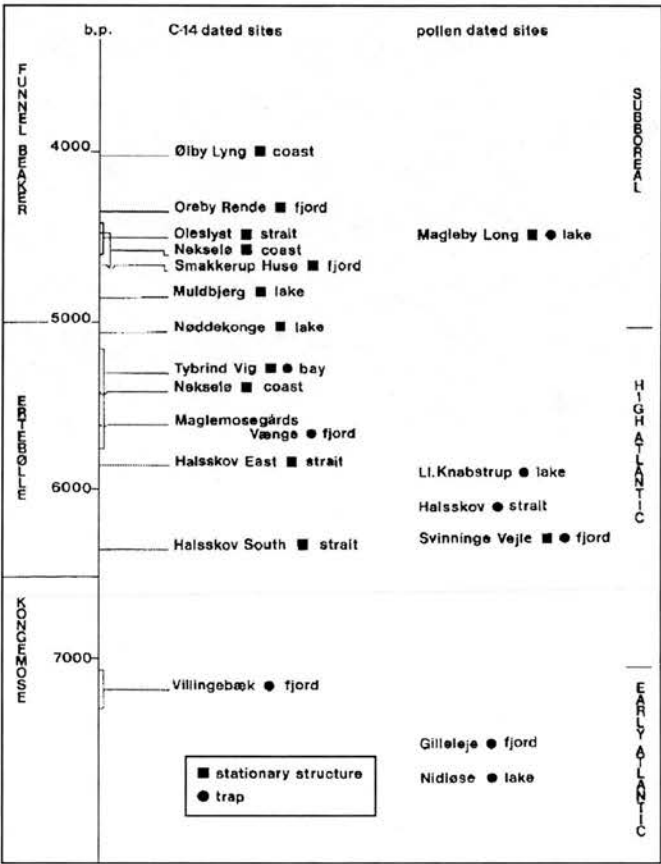


Figure 3.35 Chronology of Mesolithic and Neolithic Danish fishing structures (after Pedersen 1997).

### **Competing theories: The cause for Neolithization of Denmark-Scania**

Evidence suggests that when cattle and pigs were introduced they were already biologically domestic-type animals and no evidence to suggest a wild-type species evolution to domesticates exists in the archaeological record of southern Scandinavia (Larsson 1990; Fischer 2002). This data could be used to suggest an immigrationist argument, however there is other evidence to consider and the argument for immigration has been abandoned (Fischer 2002). Domesticates were probably introduced from southeastern sources (Thorpe 1996; Fischer 2002), though there may have been interbreeding with wild type animals (Rowley-Conwy 1995). Activities thought to have been introduced with the TRB, such as forest clearing and axe and dagger sacrifice were previously used as evidence of new and different cultural activity (Fischer 2002). This hypothesis was later refuted, because axes and vessel sacrifice appeared prior to the TRB, while forest clearance did not emerge until later centuries of the Neolithic. Fischer also argues that a significant hesitancy would have existed for any migrating culture, given the violent behavior of indigenous populations. Despite this, violence is often met with violence, and there exists a record of violent behavior in late Mesolithic, possibly the result of territoriality (Karsten 2004). Further strengthening the evidence in opposition of the migration model, the continued use of fishing installations throughout the early and middle Neolithic can be considered evidence for cultural continuity (Pedersen 1997; Fischer 2006).

Agriculture may have been introduced in its initial form as prestige items in southern Scandinavia (Fischer 2002), a notion suggested in other regions of Europe (Rowley-Conwy 1995; Zvelebil 2001; Mlekuž 2003). Wealth and power are commonly displayed by prestige items: goods which are either difficult to accrue due to rarity, or require specialized and skilled production. Domesticated animals may have been status symbols, representing a "large quantity of meat" butchered at will (Fischer 2002, 376) and the idea that feasting occurred in pre-Neolithic cultures has been discussed in a variety of European contexts (Hayden 1995, 1996; Miracle 2001).



Sexual and social stratification based on diet may have existed.<sup>42</sup> This would further fortify the position of food as an indication of status or as a prestige good in southern Scandinavia (Fischer 2002). The examination of population dietary indicators show that female individuals would have eaten mainly marine food, while the male diet appears to have included higher levels of terrestrial meats, of either hunted, or domesticated animals. Fischer also makes an ethnographic comparison to North American Indians to support these claims. Farming therefore, is argued to have been adopted after a period in which domesticates were known, but not used as a primary means of subsistence. Domesticated foods were restricted to special occasions, until the processes of agriculture and eventual animal husbandry became cost-effective (Fischer 2002). Despite this hypothesis, the transitional time during this Mesolithic use of domesticates as prestige items could not have endured a long period, as there is no increase in examples of pre-Neolithic sites where domesticated animals are found to have been consumed.

### **Underwater sites in Northwest Zealand & population pressure models**

“The quality and size of coastal settlements have often been referred to as indications on increasing population numbers and density toward the end of the Mesolithic.” (Fischer 2002; 367) Population levels during the Ertebølle, which occupied Denmark-Scania for over a millennium prior to the Neolithization, suggest that permanent settlement patterns, and higher population do not indicate population expansion as a cause for the introduction of Neolithic economy. It has been argued<sup>43</sup> that population expansion during the Neolithic would have pushed people to the marginal areas of the Danish islands. Previously, it was suggested that within the region of Northwest Zealand population of the late Ertebølle appeared to expand on the outlying islands (Fischer 2002). This was used as an indication of increased population on the mainland of Zealand and the onset of the Neolithization. The

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<sup>42</sup> The topic of dietary analysis to define social stratification is not discussed in great detail here, and is mentioned only to illustrate one modern archaeological debate as it is applied to the Neolithization of southern Scandinavia. Further discussion on this matter is outwith the realm of this dissertation.

<sup>43</sup> Fischer (2002) cites Paludan-Müller (1978) in reference to early population explanations for the Neolithization in southern Scandinavia.

resulting conclusions were that Neolithization occurred as a result of population pressure.

The results of underwater discoveries refute this claim (Fischer 2002). Explorations around these small islands show that they were extensively settled during the Ertebølle, and Kongemose as well. Thus, the population pressure model for the introduction of the Neolithic package was proved incorrect as a result of data from underwater discoveries (Fischer 1993, 1995, 1997). This example highlights the role of underwater archaeology in re-examining evidence, and thus redefining the theories for the explanation of the Neolithization process. Furthermore, “sunken Ertebølle sites off Lolland-Falster and southern Jutland can also be expected to contain important information about the route taken by Neolithization to Denmark and the remainder of Scandinavia” (Fischer 2002, 385).

#### **‘Votive’ sites from the Danish Neolithic**

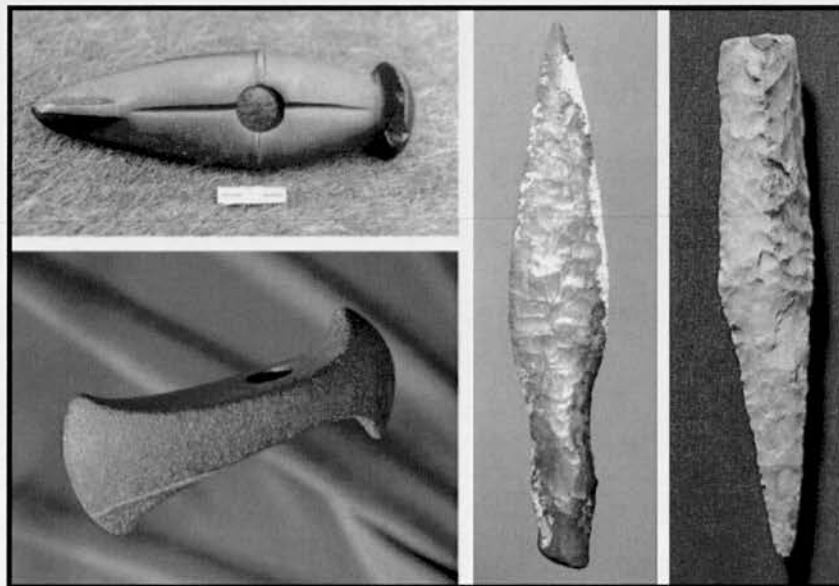


Figure 2.36 Neolithic daggers and axes are suggested to have been deliberately placed in the water as votive offerings (Fischer 2004)

Votive finds have been present in underwater archaeological discovery since the 1950's (Goggin 1960) and evidence for such activity in the Neolithic of southern

Scandinavia (Fischer 2002, 2004) exists. It is suggested that Neolithic people deliberately deposited goods into protected areas, including fjords, and narrow straits. This practice is compared to inland sites, where prestige goods were sacrificed in lakes and mires (Fischer 2004). Axes, flint daggers and pottery have been recovered in excellent condition from these sacrificial sites, which suggests their purposeful abandonment (fig 2.36).

## **2.7 Conclusion: Underwater Archaeology and Stone Age Southern Scandinavia**

The submerged discoveries of the Mesolithic and Neolithic of southern Scandinavia have been discussed both within the context of their general contribution to the archaeological record, and within the temporal chronology. The results demonstrate both the unique contribution and the importance of the underwater archaeological work carried out in southern Scandinavia over the past three decades (Malm 1995; Skaarup 1995). Understanding geological and topographical developments within the cultural landscape is critical to establishing the archaeological record. In the case of the submerged sites of southern Scandinavia, a comprehensive and detailed assessment of the physical geography has assisted not only in finding underwater archaeological discoveries, but also in establishing a tested method for the presupposition of these late Stone Age sites.

The practice of fishing, in particular, is significant to the understanding of the periods in question, for the based on the technological, dietary, and settlement data it provides. Additionally, questions and theories regarding population density, territoriality, and even social organization stem from discoveries, in many cases from submerged environments. Dietary analysis of human remains shows the complexities of human subsistence throughout the Mesolithic. Species-specific trapping, particularly of eels, and the addition of ceramic vessels help confirm that southern Scandinavians during the Ertebølle were fully sedentary Mesolithic people able to catch and store large quantities of food.

The most outstanding examples of underwater archaeological discovery, organic remains, such as those found at Tybrind Vig, Møllegabet, Korsør Nor and Wismar Bay, illustrate elements of the Mesolithic which could not be illuminated without underwater archaeological methodology. Such artifacts and preservation are unique not only to the regional archaeological record, but in several cases, to European prehistory. Underwater evidence used to discuss the Neolithic process comes from underwater archaeological material, including fishery stations, and sacrificial votive sites. Information regarding the Neolithization is obtained not only from the Neolithic evidence itself, but also from earlier finds from the Mesolithic. The Neolithic process, primarily defined by agriculture, but also including the introduction of new technologies, increased population density and pressures necessitating change, is reliant on a thorough understanding of populations, subsistence and technology from Mesolithic cultures. Only when the Mesolithic is defined through material culture, organic remains and the resulting conclusions inferred from these data, can the earliest Neolithic be defined as a process or transition, leading to the completely agricultural Funnel Beaker occupation of southern Scandinavia. Thus, underwater archeology's contribution to the definition of the Mesolithic, especially the Ertebølle culture of Denmark and Scania is unquestionably important in the discussion of the Neolithization process.

The question remains: can Fischer's assertion that predictive modeling and underwater survey be applied internationally (Fischer 1993) and be successful outside of Scandinavia?

*"In most coastal regions around the world the submerged settlements may represent the largest and most significant source for the study of [Mesolithic] societies. The Stone Age sea floor is thus at the same time a major challenge to archaeological research and a heavy obligation for cultural heritage management in most parts of the world."* (Fischer 1995, 435).

The following chapters discuss the background research and fieldwork methodology for an initial attempt at the theoretical application and adaptations of the Danish model as applied to the archaeological context and physical conditions of the northeastern Adriatic.



## Chapter 3

### Holocene Transitions in Western Slovenia & the Eastern Adriatic

## Introduction

The underwater archaeological fieldwork conducted in Slovenia was born from an interest in the Mesolithic-Neolithic transition and the Neolithization process, both regionally and within Europe.<sup>44</sup> This chapter will outline the research that has been conducted in western Slovenia and the neighboring coastal zone of the eastern Adriatic to provide a context for the research questions presented herein. In particular, questions concerning the Neolithization process, theories of population migration, cultural diffusion and the spread of a pastoral-herding subsistence are addressed critically with respect to the colonization of the eastern Adriatic and the earliest evidence of domesticates.

An overview of the late Mesolithic and Neolithic of western Slovenia is presented in this chapter through archaeological and paleoenvironmental perspectives. Open air and cave sites in wetland, karstic, and coastal environments have produced individual finds as well as more comprehensive sites. Furthermore, environmental data has been obtained from a variety of sites and coring locations that will be discussed to illustrate the conditions of the prehistoric environment. The coastal zone of Slovenia will be shown to be particularly lacking in prehistoric archaeological evidence, which reinforces the questions presented throughout this dissertation: can underwater archaeological methodology be applied to the eastern Adriatic with successful results? Can future studies of the submerged paleolandscape help define the archaeological record in a region where a limited absolute chronology has resulted in poorly-defined Mesolithic and early Neolithic periods?

This chapter will also highlight the significant debates in the field regarding the Neolithization process which includes the notion of a so-called Mesolithic refuge

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<sup>44</sup> Due to the potential importance of the eastern Adriatic and Slovenian evidence for Mesolithic and Neolithic archaeology within central Europe, the University of Edinburgh department of Archaeology has cooperated with Ljubljana University since 2002 excavating the karstic rock shelter site of Mala Triglavca. Mala Triglavca was initially excavated by Leben (1988); the available evidence has been re-analyzed (Turk *et al.* 2004; Žibrat Gašparič 2004; Petru 2004) prior to or during the most recent excavations.

zone of Istria into the 6<sup>th</sup> Millennium BC introduced by Chapman & Müller (1990), and the introduction of domesticates in earlier Mesolithic contexts (Biagi *et al.* 1993; Mlekuž 2003). The contribution of the Slovene and eastern Adriatic coastal evidence is important within the greater theoretical debates of the Neolithization processes which began last century and remains hotly-debated in prehistoric European archaeology (e.g. Childe 1925; Piggott 1954; Ammerman & Cavalli-Sforza 1971; Zilhão 1991; Thorpe 1996; Zvelebil 2001; Ammerman & Biagi 2003) and as such, will be presented within a greater European context.

It would not be possible to discuss past human development in the northeast Adriatic without acknowledging the rapidly changing physical environment during the final Pleistocene and early Holocene. Due to the geographic location of Slovenia, positioned between the Adriatic Sea, the Alps and the Pannonian Plain, the region itself becomes an intersection of central, western and Mediterranean Europe (fig. 3.1). The archaeological contribution of western Slovenia is relevant to the Neolithization of central Europe and thus merits consideration within the European archaeological record. The impact of changes in the physical geography, and coastline would have been particularly great in the northeast Adriatic region as it is widely accepted that sea level rise throughout the early Holocene (van Andel 1989; Marocco 1989; Boschian 1993; Lambeck *et al.* 2004) would have inundated coastal and plain sites in the region (Barfield 1972; Marocco 1989; Boschian 1993; Budja 1996; Biagi 2003; Forenbaher & Miracle 2005).

The publication of *Stariji Neolit u Dalmaciji*, by Batović in 1966, defined the Neolithic of Dalmatia and outlined the existing work in the eastern Adriatic region by listing the known sites from the late Pleistocene and early Holocene. A decade later Batović published the section entitled *Jadranska Zona in Praistorija Jugoslavenskih Zemalja Neolit* (1979) on the Neolithic evidence in the Adriatic zone. Brodar & Osole (1979) contributed the preceding volume of the same series, which discussed the Paleolithic and Mesolithic from Slovenia: *Nalazišta Paleolitskog I Mezolitskog Doba U Sloveniji*. These volumes have become



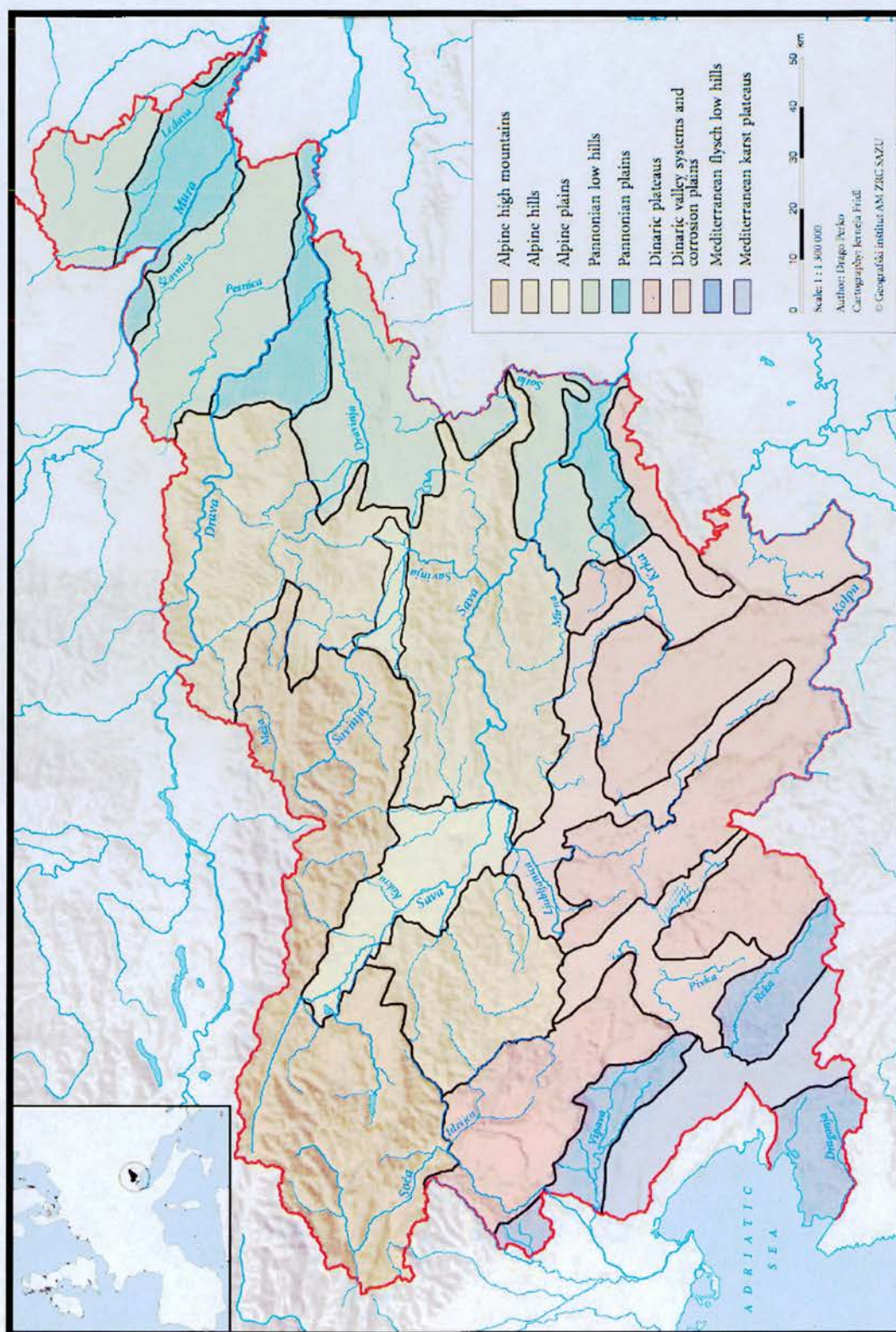


Figure 3.1 Modern map of Slovenia by geographic region (after Perko 1998).



benchmark site-compilations of the region and are often cited in synthesis when new data becomes available, new sites are discovered, and when known data is reexamined (e.g. Müller 1994; B. Bass 1997; Velušček 1999; Budja 1993; Mlekuž 2005; Budja & Mlekuž 2006). Many of the sites listed in these early publications are mentioned only in short summary, often without reference to excavation methodology. Since Batović's publications, the Neolithization of the region has become a focus of research. There continues, however, to be a lack of an absolute chronology since there are very few radiocarbon dates in Slovenia<sup>45</sup> and traditional typological chronologies continue to be employed.

### **3.1 The Neolithization of Europe: A Century of Debate**

The Neolithization process varies spatially and temporally throughout Europe during the early to middle Holocene and has been debated and scrutinized for nearly a century. Since Childe's *The Dawn of European Civilization* in 1925, archaeologists have struggled to agree on the time and location of the beginning of the Neolithic process and on the means of identification of a 'Neolithic culture'. In order to frame the discussion concerning the Neolithization of the northeastern Adriatic, an introduction to the Neolithization of Europe is required. Thus, a brief overview of the current theoretical discussions, archaeological evidence and relevant debate is presented to provide context and illustrate how underwater archaeological methodology can contribute to this on-going debate.

Piggott (1954) introduced the notion of two potential scenarios of migrating agriculturalists and indigenous hunter-gatherers and the resulting Neolithic societies in Britain. This dualistic paradigm of migration versus diffusion has taken many forms and the past several decades have seen explanations and definitions of the Neolithic process through a variety of means, evidence, and theories. Ammerman & Cavalli-Sforza (1971) introduced the 'wave of advance model', which assigned the approximate rate of Neolithic expansion or an 'agricultural frontier'. This

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<sup>45</sup> Recent publications by Mlekuž (2005, supplemental data) and Budja & Mlekuž (2006) are the exceptions to a lack of absolute chronology in western Slovenia.

publication sparked decades of renewed and often intense debate and disagreement (Zvelebil & Zvelebil 1988; Ammerman 1989) which has involved: Neolithization process defined by ceramic production (e.g. Chapman 1988), discussions of genetic evidence (e.g. Ammerman & Cavalli-Sforza 1984; Richards 2003), linguistic approaches (e.g. Zvelebil & Zvelebil 1988), and taphonomic studies of domesticated animals and their relationship to Neolithic layers at transitional sites (e.g. Bernabeu *et al.* 2001), radiometrically (e.g. Zilhão 2001) and the re-evaluation of existing absolute chronologies (e.g. Rowley-Conwy 1995).

Through such multi-disciplinary investigations, the Neolithic transition has been described in general terms as the introduction of Agro-Pastoral subsistence economy which emerges with new tool technologies, such as polished stone tools and pottery. The Neolithic has been defined by the introduction of sedentary life, as Hodder (1990, 41) has argued that the “concept of a home” was used as a metaphor for Neolithization and adoption of domestication. This notion includes the creation of larger social units, and also the changing society, which comes with such growth. The debates focus mainly on the question of the time in which the first Neolithic groups existed and who they were both biologically and culturally. Did indigenous Mesolithic groups become ‘Neolithic’, or were there foreign Neolithic groups who migrated? Did the migrating populations exterminate or absorb the indigenous communities? Did they intermix both socially and genetically? Was there social exchange and trade? Was the process violent? How might such elements be observed in the archaeological record? These are some of the questions, which continue to inspire debate amongst modern prehistorians.

Zilhão (1993, 1997) has proposed that the migration of Mediterranean Neolithic cultural groups took place not as a single process, but rather through multiple instances of pioneering and a series of individual embarkments from East to West. This hypothesis has become known as the ‘Leapfrog Colonization’ theory (Zvelebil 2001). Zilhão’s studies of Neolithic groups living in proximity of Mesolithic foragers in Portugal are used as primary data, which in turn illustrates the complexity in the migration of early agriculturalists, and has debunked the existing

paradigm of migration versus diffusion. These assertions are reinforced through radiocarbon evidence from the available data in the western Mediterranean (Zilhão 2001).

In recent years, emphasis on the complexity of the process has become a trend in the archaeological community. The following mechanisms of diffusion are suggested by Zvelebil (2001, 2) and paraphrased below:

(1) *Folk Migration*: whereby a directional and major population movement to a previously identified region causes sudden gene replacement.

(2) *Demic diffusion*: a sequential colonization of a region by small groups or households. This occurs over many generations involving the slow expansion of farming populations, which colonize new areas by the 'budding off' of hamlets from agricultural settlements in a non-directional pattern. This causes gradual gene replacement.

(3) *Elite dominance*: which involves the penetration of an area by social elite and subsequent imposition of control over the native population. This causes gene mixing, genetic continuity with genetic ad-stratum, and the retention of genetic markers of intrusive population.

(4) *Infiltration*: which involves a gradual penetration by small, usually specialist groups of a region, who fill a specific economic or social niche such as itinerant smiths, tinkers, leather workers, livestock herders. This may be genetically undetectable if there is no inter-group gene flow. If gene flow occurs a small scale genetic signature can be expected, as seen in the elite dominance model.

(5) *Leapfrog colonization*: which denotes selective colonization of an area by small groups who target optimal areas for exploitation, thus developing a farming enclave settlement among native inhabitants. This causes genetic replacement, which is

regionally variable: creating genetic islands; but may be diffused in time through gene mixing with the local population.

(6) *Frontier mobility*: which denotes small-scale movement of population within contact zones between foragers and farmers, occurring along the established social networks, such as trading partnerships, kinship lines and marriage alliances. This causes gene mixing marked by graded patterning in gene frequencies between genetically distinct populations. However, if the populations were genetically similar, this could be difficult to detect in the archaeological record.

(7) *Contact*: which takes place through trade or exchange, and within the framework of a regional or extra-regional trading network. This would have served as a channel of communication by which innovations, including domesticated plants and animals, spread. Genetic replacement does not take place due to migration and genetic continuity.

However, this expansion upon theoretical explanations for the Neolithization process is not universally accepted. Richards (2003) re-simplifies Zvelebil's seven suggested models: reducing the first to "classic migrationism" and models two through six as "integrationist" (Richards 2003, 160). Richards has rejected acculturation model 7 and the elite dominance model 3 in his use of archaeological markers along with genetic evidence implying colonization during the early Neolithic in the northwesterly route, consistent with Ammerman & Cavalli-Sforza's migration model. Richards also eliminates models 1 and 2 citing mtDNA and Y-Chromosome genetic evidence which "imply a minor overall contribution to modern lineages of less than a quarter suggesting that large scale demic diffusion or even replacement can also be ruled out" (Richards 2003, 164).

Thus the debate, which began in the early 20<sup>th</sup> century, continues in the modern archaeological community, which now concentrates on migrationism versus diffusionism versus integrationism. Zvelebil's seven suggested models may not be universally accepted; however they provide a variety of ideas expanding the existing



theoretical paradigms used to understand the Neolithic process. There is an additional trend for a greater flexibility in interpreting the Neolithization process from a regional and micro-regional, or local perspective. This is the case when discussing the northeastern Adriatic (Biagi 2003; Forenbaher 2005).

### **The Neolithization of south-central Europe: Routes of expansion**

Traditional explanations for the Neolithization of south-central Europe focus primarily on the movement from southeast to northwest (e.g. Ammerman & Cavalli-Sforza 1971). Specifically, Neolithic cultural movement in the region is tracked through the Danube and the Mediterranean routes from the Balkans into central and western Europe. A brief discussion of these two routes follow, along with their relationship to the subject areas of western Slovenia and the eastern Adriatic. The eastern Adriatic falls into an ambiguous middle area between the two suggested routes and has frequently been overlooked on traditional geographical models of Neolithic expansion however, as will be demonstrated, it appears that cultural migration from the southern maritime route is significant to the Neolithization of the eastern Adriatic regions of Croatia and Slovenia (Forenbaher & Miracle 2005; Farr 2006).

### **The Mesolithic-Neolithic transition in Greece: A donor area for the Adriatic?**

The Greek island of Corfu has been suggested as the donor area for the introduction of a Neolithic economy in the eastern Adriatic (Forenbaher & Miracle 2005). This suggests that the Neolithic transition in Greece was important to the Adriatic for both cultural and human migration. Therefore, the current evidence and debates surrounding the Neolithization of Greece is useful in understanding the introduction of pottery and agriculture in the Adriatic region. Perlès (2003, 1) takes the “old fashioned” view of the Neolithization process, viewing Greece as an initial landing point, and thereby as a unique case within the Neolithization of Europe. Consistent with the pioneer colonization process suggested by Zilhão (1991), Perlès believes that the early Neolithic culture and subsistence strategies of Greece were introduced

by “small groups of varied origins, who rapidly assimilated themselves with the local hunter-gatherers.” (Perlès 2003, 110).

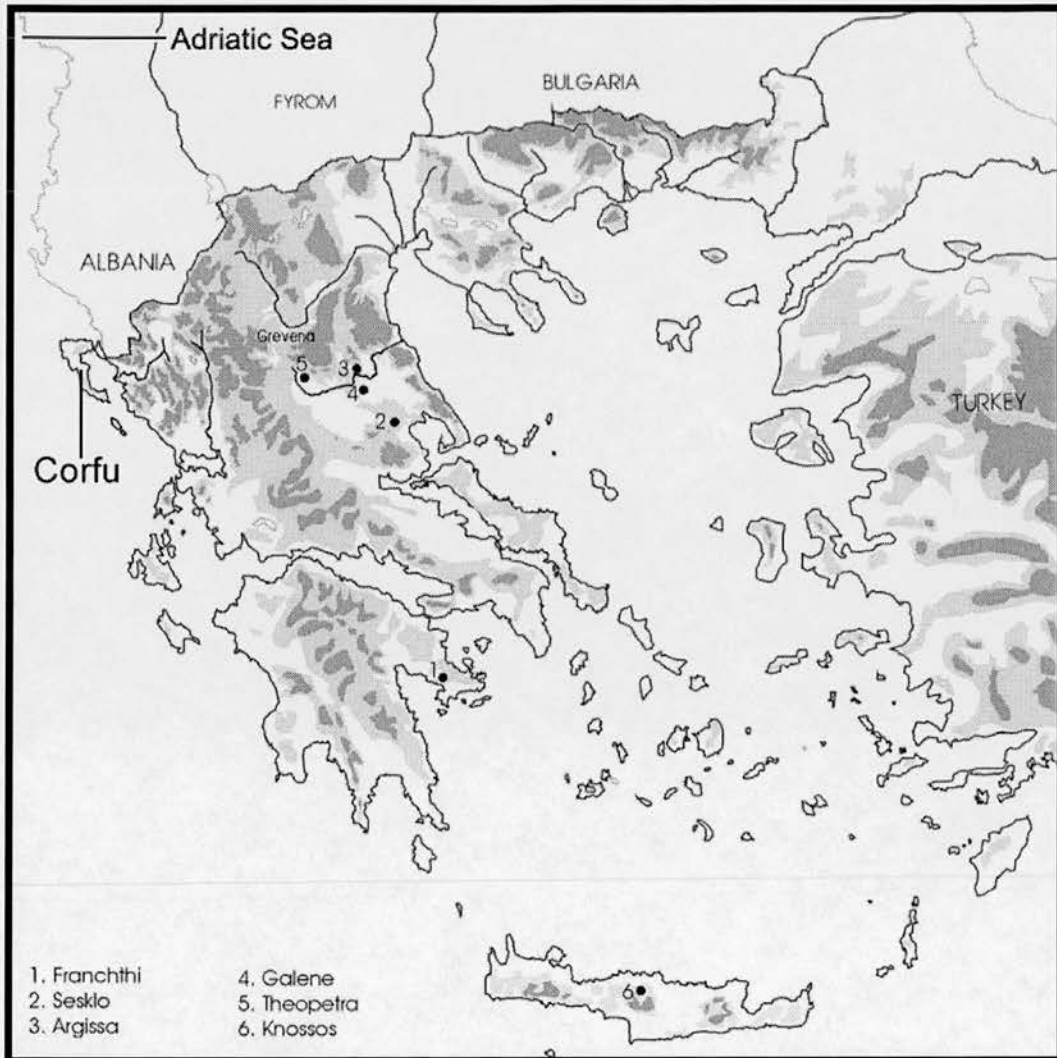


Figure 3.2 Mesolithic-Neolithic transition sites in Greece (after Kotsakis 2001). The site of Sidari on the Greek Island of Corfu has been suggested as the Donor area for the Neolithization of the Adriatic region (see also fig. 3.16).

Chronologically, the Greek definition of the Mesolithic ranges from 8700-7000 BC, by appearance a time of sparse population (Perlès 2003). Mesolithic camps appear to have been short term, and left behind only low-density of cultural material. The earliest Neolithic evidence in Greece is sparse, and sites such as Franchthi Cave indicate that the Neolithization process began by the beginning of the 7<sup>th</sup> Millennium

BC (Kotsakis 2001). As is the case with much of southern Europe, the coastal sites in Greece were affected by sea level rise in the early Holocene (van Andel & Shackleton 1982; Gifford 1983). Morphology and suggested function of lithic artifacts often constitute the main argument from transitional Mesolithic-Neolithic Greek sites, and lithic analysis is critically important (Kotsakis 2001). The difficulty with such typological distinctions, is that a sufficient distinction in typology to support the argument that there is a clear division in late Mesolithic and early Neolithic cultures does not always exist.<sup>46</sup>

While Perlès suggests a colonization and integrationist approach for the explanation of the Neolithic transition in Greece. Kotsakis argues that there is no single interpretation, economically, historically, or socially to suggest that migration and diffusion can effectively account for the complexity and variability in post-glacial Greece. “The Neolithic was not a one-way street once the first domesticates arrived in the Greek peninsula...” (Kotsakis 2001, 70). Thus, the debate on the Mesolithic-Neolithic transition in Greece continues, and until the late Mesolithic and early Neolithic are further defined in greater detail it is unlikely that a definitive answer can be found. Future site discovery will almost certainly impact this debate. Coastal sites, submerged under water and buried beneath sediments, could yield the answers to some of these questions (Flemming 1983b). For the purposes of this dissertation, however, the questions raised by the debate on the Mesolithic-Neolithic transition in Greece will remain limited to an overview, providing regional context for the donor area to the eastern Adriatic region.

#### **A brief note on the Mesolithic-Neolithic transition from the central Balkans**

Because of the proximity of the eastern Adriatic to the central Balkans, Macedonia, Serbia, Bulgaria, and Romania, this region is inherently a part of a properly contextualized discussion of the Neolithic of the eastern Adriatic. Late Stone Age sites from the Iron Gates region of the Danube Gorges have been seminal in defining

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<sup>46</sup> This blurred division of transitional lithics is also seen in western Slovenia and the northeast Adriatic and will be discussed in more detail.

the Mesolithic-Neolithic transition of the central Balkans for decades (e.g. Sreović 1972, 1979; Voytek & Tringham 1989). Recently these transitional sites have been examined from an osteological perspective (e.g. Cook et al 2002), a radiometric perspective (e.g. Borić & Miracle 2004) and an interpretive social network and cultural distribution of ceramics and ornamental artifacts (Budja 2001, 2004), which suggest social and cultural dynamics within the region. One notable element from the Lepenski-Vir culture, is the well documented on-going interaction between forager and farmer (Budja 1999); a topic which is poorly defined and of great interest in the northeast Adriatic region.

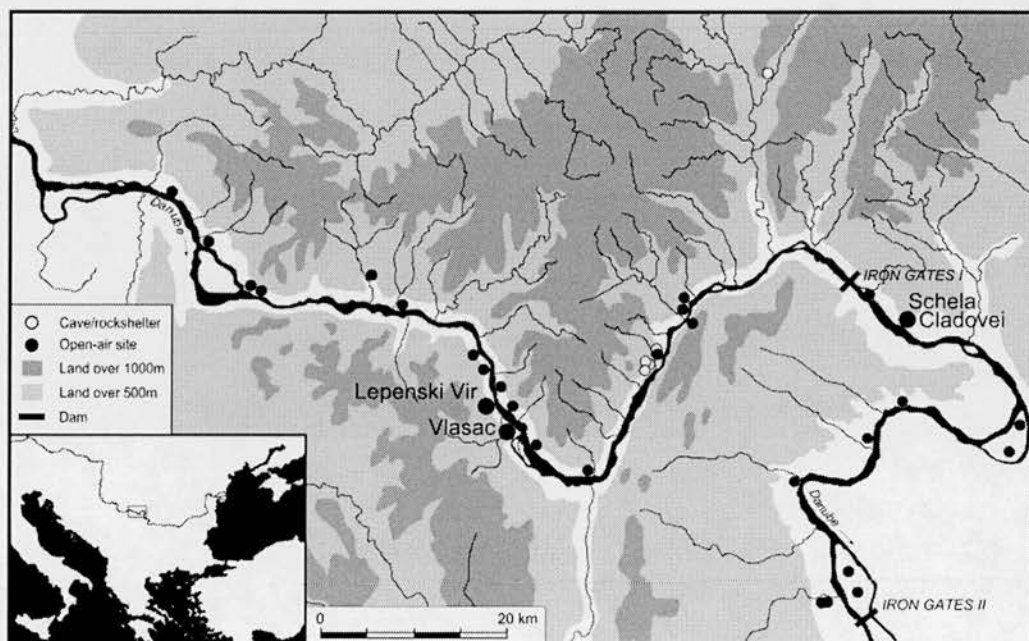


Figure 3.3 Mesolithic-Neolithic sites from the Danube Gorges are concentrated along the river (after Cook *et al.* 2002), an avenue for the transportation of people. The regional map shows the migration path for the Neolithization process into central Europe along the Danube waterway.

The omission of further detail from these sites (e.g. Lepenski Vir, Schela Cladovei, Padina, etc.) is due in part to the length which would be required, as well as the regional disconnect. The eastern Adriatic region is separated from the central Balkans by the imposing Dinarid mountain range which significantly restricted movement of prehistoric people and culture (Mlekuz 2003). Additionally, regional ceramic dispersal of early-middle Neolithic Starčevo culture distribution (Minichreiter 2001, fig.1) can be seen as a clear division of cultural dispersal



between the central Balkans and eastern Adriatic during the early and middle Neolithic. Conversely, it has been suggested that there was, in fact, relevant cultural transfer between the eastern Adriatic and the central Balkans (e.g. B. Bass 1997) based on evidence of Impressed Ware ceramics in central Balkan sites. Despite this, the Neolithic process along the eastern Adriatic is thought to have originated from the south based on ceramic typology, radiocarbon determinations and geographical modeling (Forenbaher & Miracle 2005; Forenbaher & Kaiser 2005), which will be discussed in greater detail. Additionally, this coastal zone is relevant to the methodological discussion for prospective underwater archaeological survey of western Slovenia and the eastern Adriatic.

### **3.2 Environment: Holocene Climate, Vegetation & Sea Level Change**

The Adriatic Sea, which is relatively young in its present form (fig. 3.4), is of interest for underwater archaeological potential (Boschian 1993; Budja 1996; Biagi 2003; Forenbaher & Miracle 2005; Mlekuž 2005b). Paleoenvironmental studies of the Adriatic have been discussed both within the macro region of the greater Mediterranean (e.g. van Andel 1989), a geological perspective (Marocco 1989; Boschian 1993; Surić *et al.* 2002) and in a multi-disciplinary survey of Italian territorial waters (Lambeck *et al.* 2004).

The sea level rise discussion was greatly affected by the study conducted by Fairbanks *et al.* (1989), which produced benchmark dates for global sea level change. New depth to date ratios, sea level rise curves (e.g. van Andel 1990) and reconstructions have since been developed on this data. The next paradigm shift for the modeling of sea level rise in the Adriatic sea included the consideration of tectonic subsidence and uplift (Boschian 1993; Lambeck *et al.* 2004) allowing further local interpretation and analysis of coastlines transgressed during the late Pleistocene and early Holocene.

The Gulf of Trieste, and the surrounding area also known as the *Caput Adriae* (Introduction, fig. 3), is the end of the Adriatic Sea and the northernmost point of the

greater Mediterranean Sea. The gulf itself is a shallow bay surrounded by Italy, Slovenia and a very small part of Croatian Istria. The average depth of the Gulf is approximately 25m, and did not undergo tectonic uplift but rather a minimal amount of subsidence (Lambeck *et al.* 2004). Thus, based on this sea level data, it follows that the *Caput Adriae* would have been part of a coastal plain during the late Pleistocene with in-filled river valleys along the southern side of the gulf during the early Holocene (Ogorelec 1997).

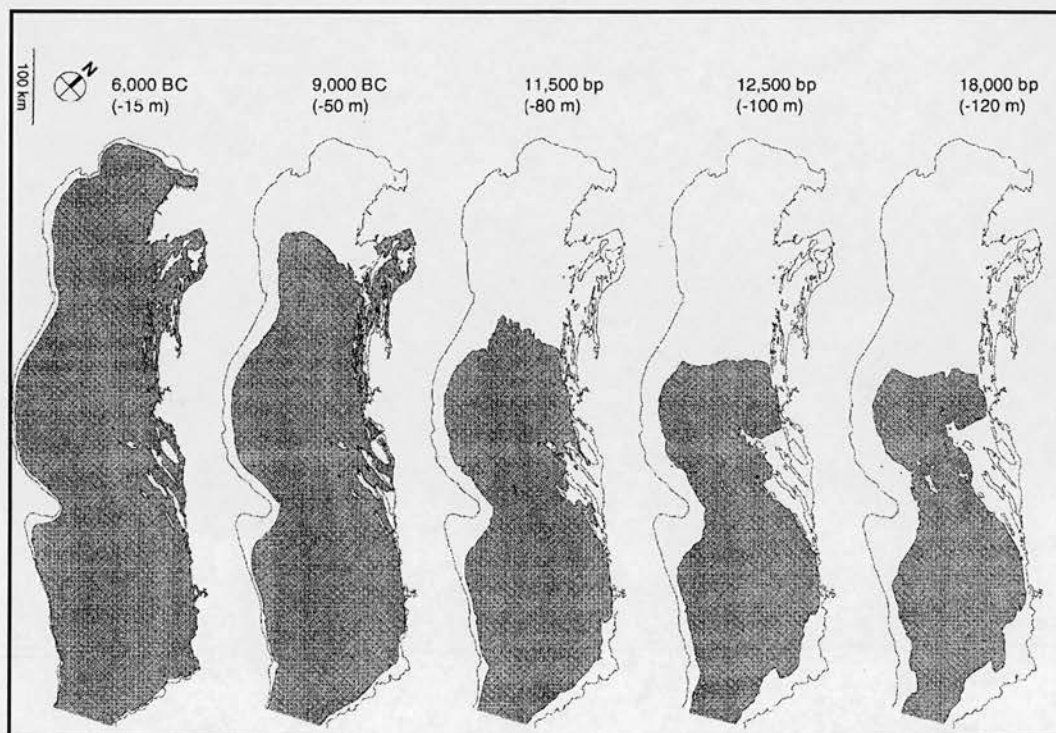


Figure 3.4 Pleistocene-Holocene evolution of the Adriatic Sea. (after Forenbaher 2002).

Modern Slovenia occupies a short coastline on the southern coast of the Gulf of Trieste. Though less than 50 kilometers long, the coast and surrounding region are archaeologically significant. The karst landscape, which makes up the eastern Gulf region (fig. 3.1), contains a large proportion of Mesolithic-Neolithic archaeological sites in comparison to the interior and eastern areas of Slovenia. The karst region has been the focus of geological and archaeological interest for over a century (Fabec 2003); and its archaeological sites are considered some of the richest in Slovenia (Turk *et al.* 2004).

Italian investigations of northern Adriatic paleoenvironments are well established and have attempted to define the region's environmental history through core sampling, reconstructions based on sedimentation (Brambati *et al.* 1988; Marocco 1991), and tectonic measurement (Boschian 1993). To the west of the Gulf of Trieste, Brambati *et al.* (2003) have produced an evaluation of the Venetian plain and lagoon, specifically land subsidence, measured at a rate of 0.5-1.3mm per year, and sea level rise, have indicated an age range of c.6000-7000 BP for the creation of the largest lagoon in the Mediterranean. Additionally, regional studies of the sedimentological and tectonic conditions which existed at the delta formed by the Grado, Tagliamento, and Marano lagoons found to the immediate west of the Gulf of Trieste (Chapter 5, fig. 5.3) are considered within reconstructions of the north Adriatic (Marocco 1991). The Gulf of Trieste is thought to have reached modern levels by c.5450 BP (Marocco 1989).

Biological, sedimentological, geological, and archaeological contributions from the Italian waters of the northeast Adriatic are described by Lambeck *et al.* (2004), who produced the most recent sea level rise curve for the northeast Adriatic (Lambeck *et al.* 2004, fig. 4). Reef building gastropods, inter-tidal organisms and the identification of lagoon species are all used as indicators, relative to core depth and radiocarbon determinations. Despite the long standing interest in the region and the multi disciplinary approach, indicating the transgressions and paleoenvironment, there is a lack of datable samples from the northern Adriatic between 7260 BC and 4680 BC (Lambeck *et al.* 2004, fig. 4). Therefore, there is a notable element of uncertainty regarding the precise sea level curve for the northern Adriatic during early Holocene (Chapter 5, fig 5.2).

Core samples from the Slovenian coastal territory at Koper and Piran Bays have provided data from the southern coast of the Gulf of Trieste (Ogorelec *et al.* 1991, 1997; Ogrinc *et al.* 2005). There do, however, exist problematic elements in the data from these studies, which require further investigation and interpretation. This will be addressed later with respect to the local importance relative to archaeological

survey and considered within the application of this data to an updated paleo-reconstruction of the Gulf of Trieste during the early Holocene.

### **Karst environment**

The Dinaric Karst of Slovenia is located slightly further inland, to the northeast of the Italian *Carso di Trieste* (fig. 3.1), and is defined by Fabec in the description of karst geography relative to the Neolithization process of the region. The karst is defined geographically by the Gulf of Trieste to the south, the Vipava valley to the north, and the Friuli Plain to the west, and the Brkini hills to the east. It is composed of Cretaceous and Tertiary limestone and dolomite with some flysch (Fabec 2003). The limestone structure causes rainfall to disappear quickly in subsurface river and cave networks. This affects the viability of the karst, as only very limited areas of standing water exist on the surface of the limestone structure. Collapse in the surface limestone form depressions known as Dolines, are often the best source of arable land, because surface clay and vegetation allow for productive soils due to the collection of surface water in these depressions (Fabec 2003).

An important consideration in the examination of karstic cave sites is the variation in sediments and varying degrees of sedimentation. When arbitrary spits are assigned, sedimentation rates must be taken into account. Podmol pri Kastelec and Vizovlje are examples of two sites in which sedimentation differs enormously. While Holocene layers make up about 7m in the former site, Pleistocene layers lie just below the surface of the latter (Velušček 1999). Additionally, as will be shown through the case of Viktorjev Spodmol (Turk *et al.* 2004), disturbance can detract greatly from a site's informative contributions in addressing the greater questions such as those of the paleoenvironment or of the Neolithization process.

### **Climate & vegetation**

Gardner (1999) has investigated early-middle Holocene environmental dynamics through the pollen record in south central Europe, and has defined the dominant



phases, which form a general pattern in the region. The patterns are as follows: early Holocene: the primary forest develops as the landscape is re-colonized by warmer weather species with high variability and quick turn-over. Middle Holocene: a secondary forest development whereby the forest soils are matured by the increased presence of canopy-forming vegetation. An expansion of the dominant forest taxon is also evident. In central Slovenia, pollen records have shown that needle type coniferous species were replaced by a mixed deciduous forest (Gardner 1997) as climatic conditions continued to improve.

Palynological investigations of the karst indicated that past forests were not sub-Mediterranean in type, but modified *Abieti-Fagetum* and *Querco-Carpinetum* forests in alternating dominance (Culiberg 1995). Post-glacial warming lasted until 6900 BC when a cooling is recorded lasting until about 6400 BC. This was followed by a fluctuating climate with a more humid environment, possibly 50% wetter than modern standards. Precipitation and cooling reduced by 5100 BC. From 4000 BC to 3200 BC another cool phase was followed by a drier, warmer climate which peaked around 2600 BC and ended around 2200 BC (Fabec 2003).

In a synthesis of Neolithic landscapes and vegetation dynamics of Slovenia, Andrič (2001) included core samples from northwest Croatia and the Triestino Karst. While the modern vegetative landscape of Slovenia appears to have formed several millennia after the Neolithic process, there is a distinct difference between Mesolithic and Neolithic era vegetation. The Slovene landscape of the Mesolithic seems to have been an open woodland of lime, oak, and hazel. A change of forest composition occurred by 6900 BC when a spread of shade tolerant trees is visible in the pollen record (Andrič 2001). No evidence of farming activity exists in the pollen records during the time when agriculture is thought to have begun. This is consistent with greater regional studies regarding the first evidence for early agricultural societies (e.g. Willis 1995), which has shown that the pollen record lags behind the initial introduction of agricultural subsistence economies.

## Environment of the Ljubljana Moor

The Ljubljana Moor (*Ljublansko Barje*) is a large wetland in the southern part of the Ljubljana basin, created by a tectonic depression, located in west-central Slovenia just 10 km south of Ljubljana. The extensive alluvial flat surface contributes greatly to dynamics of this landscape (Mlekuž 1999). Main water sources in this region are the Ljubljanica, Izica, and Iska rivers, along with the Gradascica river, the lower Alpine foothills and watersheds, or drainage basins, from the Dinaric mountains (Budja 1995). The Ljubljana Moor is known to have been home to Mesolithic cultural groups as evidenced through individual finds (e.g. the Mesolithic barbed point discussed in Turk *et al.* 2004), and Mesolithic, Neolithic and Eneolithic occupations which are well documented in Slovenian prehistory (Frelih 1986; Parzinger & Dular 1997; Strahm 1997; Mlekuž 1999; Velušček 1999; Gaspari 2003; Mlekuž *et al.* 2006; Gaspari 2006) and include the Eneolithic Ljubljana culture (Benac 1979).

Pollen samples taken from the Moor illustrate the gradual change from coniferous forest to a mixed deciduous forest around 7000 BC in central-western Slovenia (Gardner 1997). Vegetation during this time suggests a temperature 5°C warmer than modern climate. By 6000 BC there was an expansion of Hazel (*Corylus*), followed by an explosion of Beech (*Fagus*), which occurred quickly around 5500 BC. From 5500 – 4200 BC Beech was the dominant species, with a presence of Oak (*Quercus*) and Hazel. This period was followed by a 200 year span of Beech and Fir (*Abies*) after which an increase in Hazel is seen c.4000 BC, while Beech and Fir become less prevalent. By 3000 BC, the presence of European hornbeam (*Carpinus betulus*) pollen is present, as documented at the Ljubljana Moor site.

When Beech was dominant c.4500 BC, the large wetland of the Ljubljana moor underwent a series of predictable flooding events, which would have inundated low-lying settlements (Mlekuž 1999). This cycle of flooding would have persisted for over two thousand years. Occasional mass flooding events would have changed waterway dynamics, rivers, and canals on the Ljubljana Moor, as illustrated by GIS

landscape modeling, settlement positioning, and archaeological evidence of Neolithic and Eneolithic pile-dwellings on the Moor. There is archaeological evidence in the form of lithic scatters on elevated areas of the floodplain, likely a selective preservation of artifacts due to the topography of their find spots and the resulting protection from this measurable flooding (Mlekuž 1999; Mlekuž *et al.* 2006).

### **3.3 Early Holocene Chronology of the Northeast Adriatic**

The Neolithization process cannot be well-defined in any region of Europe until the archaeological record of the Mesolithic is well-defined. Therefore, a general overview of the Mesolithic and Neolithization of western Slovenia is discussed, along with relevant aspects of the eastern Adriatic coastal zone.

#### **Epipaleolithic evidence**

“There is no site in Slovenia in which finds from the late Paleolithic, which is represented in our near and distant surroundings by Epigravettian, and (early) Mesolithic represented by the Sauveterrian, are in stratigraphic sequence.” (Turk *et al.* 2004, 82). This is similar with the Italian and Slovene Karst (Boschian 1997). There is, however, evidence of late Pleistocene occupation in northern Istria, Croatia (Miracle 1997, 2001).

The site Pupčina Peč, in northeastern Istria, is located in a narrow canyon approximately 20km west of Rieka (fig. 3.5). First recorded in 1960, Pupčina Peč was excavated in the late 1980's and early 1990's, at which time both ceramic (Neolithic and Eneolithic) and aceramic (Epipaleolithic and Mesolithic) layers were recorded (Miracle 1997). The cave, measuring 25m wide and 30m deep, was excavated stratigraphically, following natural stratigraphy when possible and using artificial spits of <10cm when necessary. Layer 32 produced boar, red deer, and roe deer remains as well as a modest lithic assemblage with retouched bladelets and end scrapers of local chert. A hearth 1m in diameter is inferred from a layer of white ash

and burned earth. Charcoal from layer 32 yielded a transitional radiocarbon date of 10,570 BC (10610±200 BP, Z-2574), indicating a transitional Pleistocene-Holocene age. The study of late Pleistocene remains at Pupčina Peć Miracle (2001) has suggested that Epipaleolithic feasting is evidenced both by artifacts as well as by the faunal remains. Large land snails, marine mollusks, and particularly deer remains have been used to support this claim. The patterns of burning, as well as a systematic and intensive use of an entire deer carcass, evidenced through cut-marks, in the early phases of occupation are compared to a decrease in bone fragmentation and a less intensive use of the carcass from later phases. This earlier intensive utilization of the entire carcass thus suggests lacking availability of the more desirable cuts of meat, and therefore less of the resource itself (Miracle 2001).

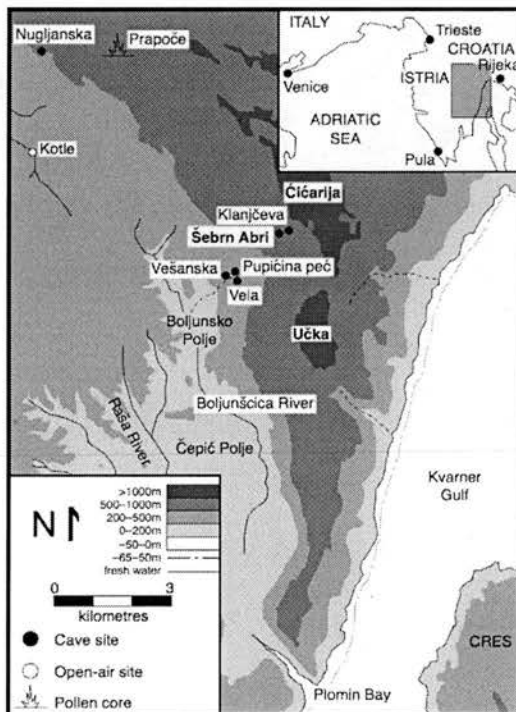


Figure 3.5 Map of northeastern Istria, Croatia with site locations, including Pupčina Peć and Šebrn (after Miracle 2000).

### 3.3.1 The Mesolithic in Slovenia

Until very recently there were no radiocarbon dates from the Mesolithic of Slovenia and sites from this period were identified solely on stratigraphical and typological classification (Leben 1988; Turk *et al.* 2004), a fact which is true for the Neolithic as



well (Velušček 1999). The definition of an absolute chronology in the Mesolithic of Slovenia is problematic since, excluding three recent radiocarbon determinations from Viktorjev Spodmol (Turk *et al.* 2004), all Mesolithic cave sites on the Slovene Karst are dated relatively and defined by tool typology and stratigraphy (Leben 1988) or through comparison with sites in Italy and Croatia. Other individual Mesolithic finds are classified as chance finds, such as the barbed point of red deer antler, typologically assigned to the Mesolithic, despite no absolute date. Thus, such finds provide little “informative power” (Turk *et al.* 2004, 16). Other sites are considered more informative by Turk, such as Pod Črmukljo and Viktorjev Spodmol which will be discussed. It should be noted that there are problematic elements of these sites, including disturbed unreliable stratigraphic context and a lack of radiocarbon determinations.

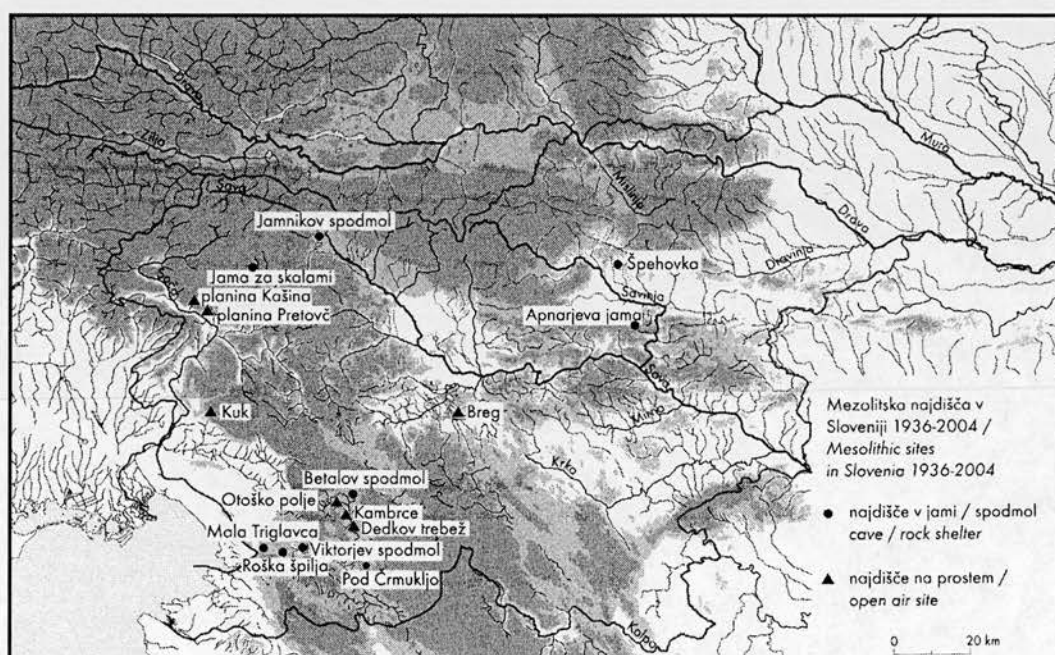


Figure 3.6 Map of Slovenia with established and suspected Mesolithic sites (after Turk *et al.* 2004).

Due to this lack of clear stratigraphy in addition to the absence of an established absolute sequence, the proposed chronology for Slovenian Mesolithic is adopted from that of the French and Italian chronologies (Turk *et al.* 2004) whereby the Mesolithic is divided into classical early and late phases: The Sauveterrian and

Castelnovian periods. Turk cites ratios of trapezes made with microburin technique as “the only reliable mark of recognition of the Castelnovian” (p.65). The actual absolute chronology of Slovenia and the northeast Adriatic will certainly vary from neighboring chronologies. This exemplifies the need for further investigations in the Gulf region in an attempt to better define the Pleistocene-Holocene transition from an archaeological perspective. Recent publications have suggested the end of the Mesolithic in the *Caput Adriae* by 5600 BC (fig 3.16).

The coastal region of western Slovenia and the Gulf of Trieste must not be addressed by its modern political borders, but from a geographic definition of the northeastern Triestino Karst, the western Slovenian Dinaric Karst, the northern Istrian low-lying coast and internal midlands and hills. It is important to address the Mesolithic record in western Slovenia and the northeast Adriatic to define the Neolithization process and earliest Neolithic occupation. Because the term Mesolithic is still used with some variability (Miracle *et al.* 2000), this section will focus on the cultures of the early Holocene, which practiced a seasonal Hunter-Gatherer subsistence as their primary economy just prior to the period in which domesticated animals and cultivated plants became the primary subsistence strategy in the region.

The Mesolithic in Slovenia has been examined since the first half of the 20<sup>th</sup> century, but there exist relatively few sites (Turk *et al.* 2004), which have produced only limited archaeological information. Additionally, Turk rightly suggests that a comparison between sites in Slovenia is a difficult process due to variety in fieldwork methodology and post-excavation methods.<sup>47</sup> Intensive caving expeditions in the Trieste Karst have meant that more caves, and thus more sites, have been identified in Italy than in neighboring Slovenian Karst (Fabec 2003). Ongoing discoveries beginning with Grotta Azzurra di Samatorza took place beginning in the early 1960's. While sites from the karst have been a focus, other areas such as the Ljubljana Moor, Vipava valley and Julian Alps should lead to a more

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<sup>47</sup> Personal and political bias can also be a strong element which can obscure objectivity, as demonstrated by Turk (2004) in criticizing “foreign literature” (p. 65) and the interpretations from the “other side of the Alps” whereby “others could learn a good deal from us, rather than the reverse” (p. 169).

representational understanding of the Mesolithic of Slovenia (Turk *et al.* 2004). Turk does not mention the possibility of coastal or submerged Mesolithic sites in the Gulf of Trieste or the greater Adriatic. This is due perhaps to a bias against submerged sites, or perhaps to a lack of underwater methodology.

Marine waterways of short distances (a few kilometers), were presumably traveled during the early Holocene by the late Mesolithic inhabitants of the eastern Adriatic (Forenbaher 1999). Evidence from Mesolithic groups of northern Europe (e.g. Grøn 1997) supports this theory, and is also seen in Slovenia in later Neolithic and Eneolithic examples of logboats from the Ljubljana Moor (Erič 1998).

Technological innovation, immigration and cultural exchange contribute to the later evidence of Neolithic watercraft and related technology. Later evidence of such methods of marine transportation can only be used as regional examples and little more. The inference of Mesolithic use of waterways is not based on archaeological material and thus an evidence based statement that Mesolithic people of the Gulf of Trieste travelled on the sea cannot be made. Such a suggestion must remain a speculation until archaeological evidence is produced. Neolithic evidence of marine transportation and the spread of culture throughout the eastern Adriatic is quite different from Mesolithic (Forenbaher 1999; Forenbaher & Miracle 2005) and will be addressed later.

### **Viktorjev Spodmol**

Viktorjev Spodmol is located at the foot of Vremščica mountain in the Reka river valley which links the Gulf of Trieste and the modern city of Rijeka, Croatia (fig. 3.6). According to Turk *et al.* (2004) the important sites from the Slovenian Mesolithic appear along this line. Details from Viktorjev Spodmol are paraphrased herein, based on Turk's report. The finds from Viktorjev Spodmol are mainly lithic and faunal, and have mainly been typologically and stratigraphically dated. However, because the arbitrary strata were assigned to a site, which has undergone at least two "sedimentation events" (Turk *et al.* 2004, 72), which would have affected any mobile objects, the principles of stratigraphic assignment must be

examined carefully at Viktorjev Spodmol. Arbitrary spits were employed whereby spits 1-7 were defined as later prehistoric, while the spits and below are defined by Turk as Mesolithic layers. This may be based on the obvious disturbance and intrusion of glazed pottery found in spit 7, as well as on evidence of new world pollen in upper levels which implies modern contamination only centuries old in the top half of the strata (Turk *et al.* 2004).

Turk acknowledges that there can be no successful classification of pollen samples based on the problematic stratigraphy evidenced by these recent deposits. Seeds and charcoal were collected through sieving and, not surprisingly, have demonstrated similar issues upon further analysis. Turk does not believe that this monumental problem has impacted lithic material and states that there is “the possibility of other small finds except for artifacts, not always, being contemporary with sedimentation.” (Turk *et al.* 2004, 74). As much of the excavated material appears out of context due to sediments and intrusion, it seems peculiar to suggest that the lithic artifacts would remain impervious to such disturbance. Nevertheless, Turk insists that Viktorjev Spodmol is “from all points of view amongst the richer Mesolithic sites south of the Alps and can be set alongside sites in N.E. Italy.” (Turk *et al.* 2004, 169). This illustrates not only a lack of attention to the evidence, but an obvious bias of the investigators for validation of his detailed presentation of the evidence taken from a severely disturbed site. This problem has been acknowledged within the archaeological community, and according to Miracle “excavation bias is a problem of many sites key for studying the Mesolithic-Neolithic transition in the northern Adriatic; most have been excavated quickly and coarsely over large areas or have been tested with precision in very small trenches” (Miracle 1997, 57).

Human remains consisting of two individual phalanges from an adolescent and an incisor from a child supply limited information about the occupant community itself. Bone tools are fragmented, and not of the quality to provide radiocarbon dates. The lithic collection is made mainly from local chert from the Reka river at which most typical Mesolithic tool types are found: triangles, micropoints, microliths, and microblades (Turk *et al.* 2004). The lack of ceramics and domesticated bones can also



be used to infer a strictly Mesolithic site. Thus the faunal evidence can be used to suggest the subsistence strategy of the large game hunter-gatherer, as well as providing insight into hunting patterns and seasonality based on species typology from a general temporal perspective.

There are three radiocarbon determinations from faunal analysis, which provide a window of the occupation of this site, however the stratigraphic confusion of the results speaks itself. An Elk tooth from spit 6 yielded the date of 9390 BC ( $9930 \pm 50$  BP).<sup>48</sup> It should not go unnoticed that this date from spit 6 comes from the level *above* spit 7 where an intruding glazed ceramic sherd was recovered. <sup>14</sup>C data from 'bones' from spits 15 and 16 gave dates of 7370 BC ( $8300 \pm 50$  BP) and 8980 BC ( $9560 \pm 50$  BP) respectively (Turk *et al.* 2004). The absolute dates are valuable in so far as that they indicate human occupation during a period, which can be thus loosely associated with the lithic typologies. Assertions of precise occupation periods or dates of typologies are surely impossible given the limitations of such data, and the stratigraphic situation. Likewise, the lithic finds from Viktorjev Spodmol can be typologically assigned with some degree of clarity. Both lithic and faunal analysis, lengthily studied, must be viewed critically due to their origin of a severely disturbed environment. Any comparison based on the stratigraphy of Viktorjev Spodmol should be reexamined automatically.

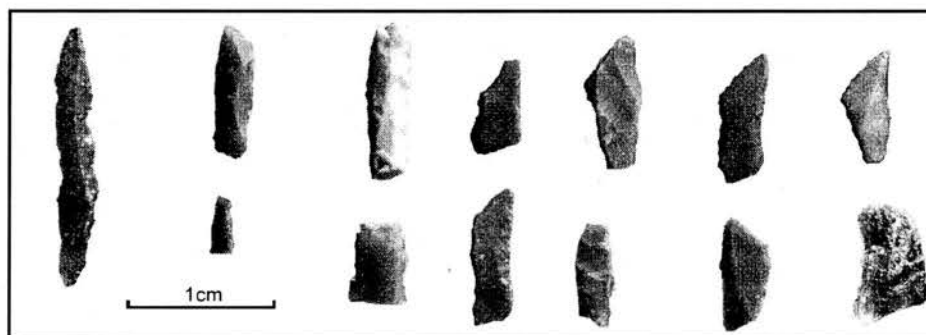


Figure 3.7 Selected microliths from Viktorjev Spodmol (after Turk *et al.* 2004).

<sup>48</sup> The site was dug with artificial spits wherein spit 1 begins at the modern surface and spit 2 is directly beneath, etc.

## Mala Triglavca

The site of Mala Triglavca near the modern town Divača is the first cave site in Slovenia to yield definite pre-Neolithic bone industry (Leben 1988). It was excavated by Leben in 1979 by a test pit; then in 1980-1982 the western side of the 8m wide, 6m long, 1.8m high cave was excavated. 0 to -2.6m below surface were recorded as post-Neolithic, -2.6m to -3.5m were defined as a Neolithic layer by the presence of ceramics; and -3.5m to -4.5m made up the lowest Holocene layer. The final layer was aceramic; but contained bone and antler artifacts as well as microliths, although stone tools were scarce in the initial test trenches of the Mesolithic layer. Antler tools such as mattocks and hammers were also discovered in this Mesolithic layer, which was a dark rubble with a charred gray ash deposit and included the remains of two hearths (Leben 1988).

Leben's excavations did not yield absolute dates; however, the spoil heaps from these excavations were re-examined and sifted in a later analysis by Turk *et al.* (2004). A single radiocarbon date from a *Mytilus* shell in what was thought to be the Mesolithic layer was dated to the Eneolithic.<sup>49</sup> In total 348 lithic tools were recovered along with 280 fragments of pottery, 34 perforated shells, a bone awl, and what has been interpreted as a fragment of a bone flute, which were excavated by Leben during the 1980 – 1985 seasons (Turk *et al.* 2004). Eventually, several hundred additional lithic fragments were recovered, a vast majority of which were assigned to the Mesolithic. In total around 800 chipped stone tools have been recovered from the Mesolithic layers (Petru 2004).

Results from a microbeam PIXE mapping usewear analysis of three end scrapers and a single flake from the Mesolithic layers at Mala Triglavca demonstrated that hunting and butchering was carried out close to and at the site (Petru 2004). Projectile point production and hide working are implied by evidence from the analysis of this small test group, which was controlled through the comparison of

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<sup>49</sup> The sample was thought to have been taken from the Mesolithic layer, however it appears to have been taken from Leben's original spoils, and thus recently disturbed.

lithics produced through experimental archaeology. The end scrapers show traces of hide working indicated by sulfur, potassium and calcium residue; the presence of phosphorus on one scraper is thought to represent bone working or butchering. Stone tools were also analyzed on a macro-scale at 50-200x magnification. Mesolithic finds from Mala Triglavca are composed of local chert, which differs from the higher quality non-local material from Neolithic flint artifacts (Petru 2004).

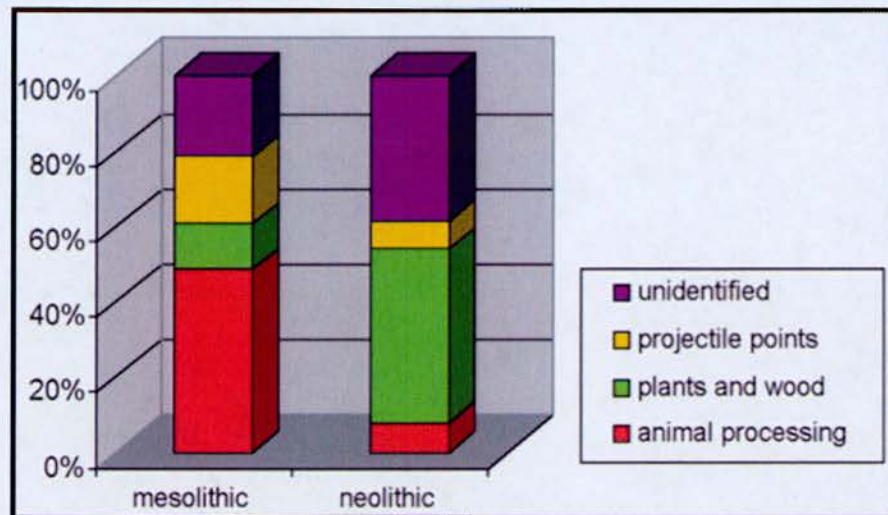


Figure 3.8 Mesolithic and Neolithic usewear analysis from the stone tools at Mala Triglavca (after Petru 2004). It is important to note that the total quantity of Mesolithic flints grossly outnumbers those from Neolithic layers.

Since the Slovenian evidence from the Mesolithic is limited and does not come from stratigraphically identifiable sites, comparison of lithic typological ratios has been conducted using Italian evidence to relatively define site ages (Turk *et al.* 2004). Based on evidence from Italian sites, Turk has determined that the ratio of trapeze to triangle lithic material is a viable method of differentiating older from later Mesolithic materials, when stratigraphy is unhelpful and no radiocarbon determinations evident. However this methodology must be considered comparative extrapolation. Nevertheless, Turk *et al.* (2004) has stated that Viktorjev Spodmol is older than Mala Triglavca, based on comparisons of triangle to trapeze ratios with the established Italian chronology, though he does not define the control group(s), their contexts or excavation techniques in great detail.



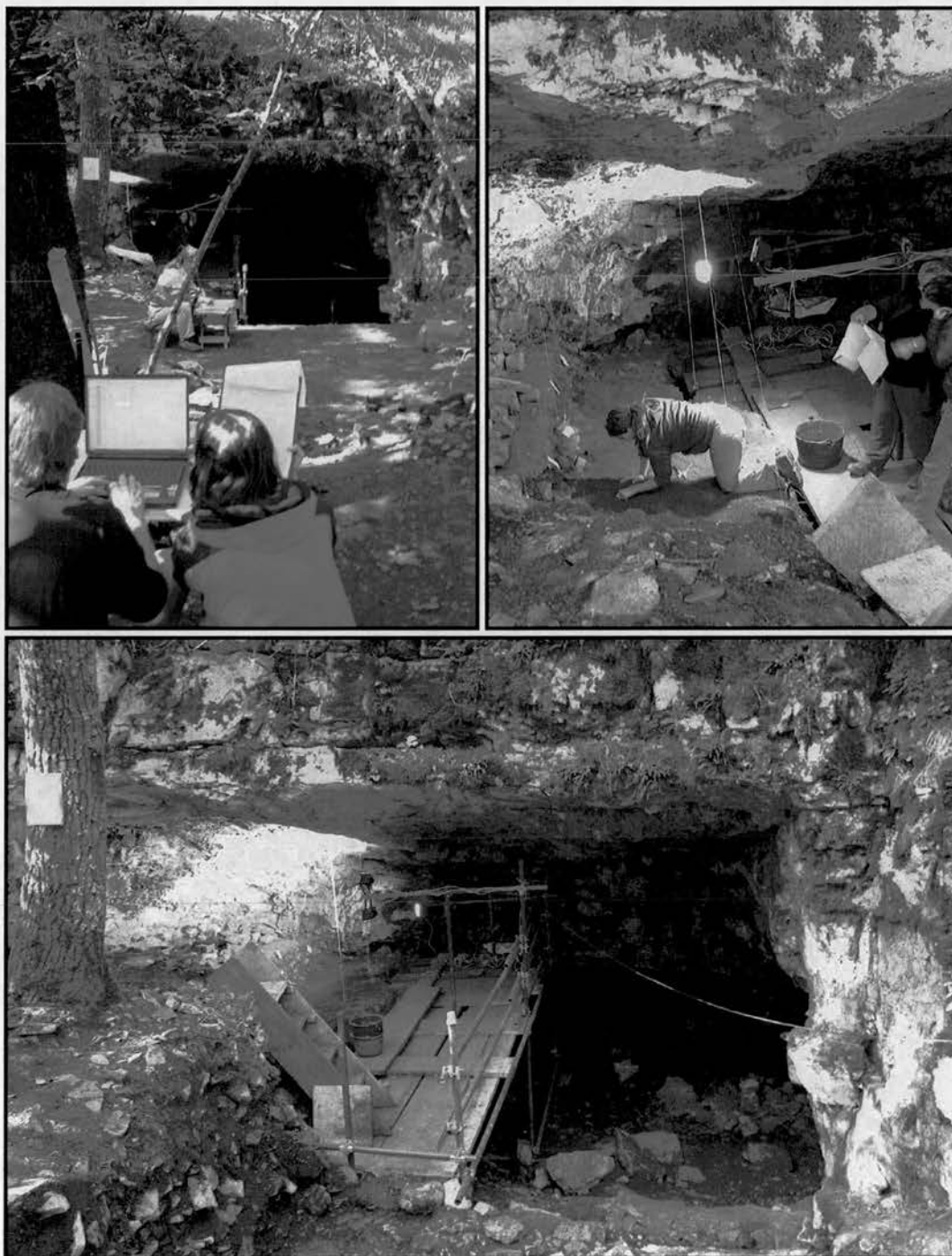


Figure 3.9 Mala Triglavca during the 2004 Excavations (photos by author).



### 3.3.2 Mesolithic Evidence from Western Croatia: Istria & Dalmatia

Miracle (*et al.* 2000) has suggested Istria as an ideal location to examine the upland and hinterland landscapes of the Mesolithic. While coastal and lowland sites represent Mesolithic sites in middens and habitation sites, Istria and the Dinaric Karst provide plenty of cave sites, and rock shelters (e.g. Biagi *et al.* 1993; Miracle *et al.* 2000; Turk *et al.* 2004). At the site of Šerbn Abri, located in northeastern Istria, three radiocarbon dates in stratigraphic sequence place levels 3 – 6 to between 7610 – 8400 BC, in the early Holocene. The lithic assemblage at Šerbn is made of backed bladelets and other tools for production of hunted game such as flakes, burins, scrapers, and piercing implements (Miracle *et al.* 2000).

The faunal remains at Šerbn appear to have changed over time, indicating a variation in hunted game during the different Mesolithic occupations. It appears that the initial hunter-gatherers who used this rock shelter scouted and monitored herds of deer. It has been suggested that initial parties used smaller game as a secondary resource with greater frequency than later hunters (Miracle *et al.* 2000). This has led Miracle to conclude that deer migrations were further refined, and later parties were more adept at seeking their prey, illustrated by the decrease in smaller less desirable prey species. This seems a reasonable hypothesis, because as faunal remains changed, consistent with datable stratigraphic layers, the material culture remained of a similar nature throughout the site. It has thus been suggested that while the material culture remained relatively unchanged, the results of the hunt improved with time (Miracle *et al.* 2000). The faunal evidence may also be comparable to the Epipaleolithic evidence from Pupčina Peć where the later phase occupation appears to have been less concerned with the full utilization of the primary hunted species. It could be interpreted that the Epipaleolithic feasting suggested by Miracle (2001) was a result of increased knowledge of the prey species, and therefore of more successful hunting campaign. This may have enabled and promoted feasting as an economic event based on resource surplus rather than a solely socio-cultural phenomenon or ritual practice.

Above the Epipaleolithic layer at Pupčina Peć is a culturally sterile period followed by evidence of a dramatically different use of the cave dated to Mesolithic occupation dated from 7830 BC ( $8708 \pm 170$  BP, Z-2635) to 8960 BC ( $9590 \pm 180$  BP, Z-2527) based on a midden from layers 27-23 (Miracle 1997, fig. 4). In these layers there exists a marked increase of land snails (*Helix*) and marine mussels (*Mytilus*). The tools have shifted from bladelet to flake production, although the typology is not vastly different; small scrapers continue to be the dominant lithic material with a notable absence of microliths and backed pieces (Miracle 1997). There is little surviving flora to interpret from the upper Paleolithic and Mesolithic layers, despite the attempts of flotation techniques.

Remains of smaller animals represent a broader diet, and are indicative of a diversification of subsistence economy. This is consistent with the presence of mollusks and can similarly be used to infer seasonality based on peak collection times. Woodland and forest edge species are identified and thought to have been exploited mainly in the Autumn. Mollusk remains support this claim as the shellfish can be collected year-round, though Autumn is identified as the likely season for the occurrence of both land snails and mussels (Miracle 1997). Land snails, best collected in Spring or Autumn, were perhaps uninteresting to foragers seeking high-fat content after enduring the preceding winter. Edible land snails are common in the circum-Mediterranean archaeological site, and have been identified as a possible marker in measuring the transition from foraging to a production economy (Lubell 2004). However, land snails can also occur as a result of a favorable natural environment particularly in cave sites. Lubell concludes that land snails are likely an opportunistic, low-prestige food resource indicating broadening spectrum of food resource. This may be an indication of changes in natural resources and the decreasing availability of large game, because changes in diet breadth can be interpreted as a reaction to changing climate and landscape (Miracle 1997).

Mobility is indicated by the quantity of marine shells, which would have been the result of a 20 km journey down the Boljunščica river. Therefore “marine shells appear to have come to Pupčina through either a move of base camp... or through

trade” (Miracle 1997, 54). No sites on the coast have been discovered, which can be linked to the cave sites of the hinterland valley. It is possible that the river itself was used as transportation of marine goods and people, although no marine craft have been recovered in the region to supply archaeological evidence for such a speculation.

There is a gap in dates (tab 3.1) from the last level of the Mesolithic (23) and earliest Neolithic level (22), which may be a result in a lack of appropriate aged deposits to supply transitional data. It should be noted that the data is based on a small excavation and a relatively low sample size of archaeological material. The faunal data however, does seem to be consistent with transitional change in the region (Miracle 1997), which coincides with the earliest ceramic layers.

Phase	Excavation levels	<sup>14</sup> C Dates (lab, level)	Calendar Age BC (at 1 $\sigma$ )	Excavated volume (m <sup>3</sup> )
Upper Midden (Mesolithic)	24, 202, 202+203, 203	9200 $\pm$ 170 (Z-2634, L 202) 8710 $\pm$ 170 (Z-2635, L 203)	8690–8240 8200–7550	0.764
Upper Silts (Mesolithic)	204, 205			0.175
Lower Midden (Mesolithic)	25, 26, 27, 203A, 206	9590 $\pm$ 180 (Z-2572, L 25) 8770 $\pm$ 310 (Z-2578, L 27)	9220–8740	0.553
Early Mesolithic	28, 29, 207, 208	9840 $\pm$ 60 (Beta-129332, L 28) 10 000 $\pm$ 270 (Z-2576, L 29–30) 11 160 $\pm$ 270 (Z-2636, L 207)	9310–9225 10 200–9200 11 500–10 950	0.387
Late Upper Palaeolithic	30, 30+31, 31, 32, 32+34, 33, 34, 34A, 35, 36, 36A, 36B, 36C, 37, 38	10 150 $\pm$ 60 (Beta-131626, L 33) 10 610 $\pm$ 200 (Z-2574, L 31–34) 10 020 $\pm$ 180 (Z-2631, L 35)	10 050–9450 11 000–10 200 10 150–9300	1.802

Table 3.1 Radiocarbon determinations and Epipaleolithic and Mesolithic layers from Pupčina Peć (after Forenbaher *et al.* 2003).

The Mesolithic evidence of Dalmatia is addressed for the contextualization of the Neolithization process of the region as related to the northeastern Adriatic. The site of Vela Spilja<sup>50</sup> is classically referenced for its contributions from Upper Paleolithic through Bronze Age occupations (Batović 1966; B. Bass 1997; Radić 2006), and provides perhaps the most information available for the Mesolithic and Neolithization of Dalmatia. Located on Korčula, Vela Spilja is a limestone cave

<sup>50</sup> This site is also spelled Vela Spila, (e.g. Radić 2006)

found near the Modern town of Vela Luka. Approximately 200 m<sup>2</sup> of the cave have been excavated to an average depth of 4m (Radić 2006).

Upper Paleolithic deposits have been excavated, and a number of lithics, faunal remains, and other material have been recovered from Vela Spilja (Radić 2006 tab. 1-3). The lithic assemblage from the Mesolithic occupation is represented by just 211 flaked stone artifacts with only nine tools exhibiting simple retouch; this figure is “negligible when compared to 1069 tools from the Paleolithic phase.” (Radić 2006, 3). There are however a greater number of bone tools, a total of 29 recovered from the Mesolithic layers of trenches f-g. Faunal material is found in the form of mainly marine resources during the Mesolithic as fish, mollusks, and snails are found, while land species are represented by wild pig, fallow deer, hare, and some red deer, which are suggested to have been hunted sporadically. While Radić suggested that bones from Tuna and Swordfish are evidence of a developed, deep-sea fishing strategy, this has been questioned by Picard & Bonsall (2004), based on the presence of these fish in marginal zones. Furthermore, animals associated with the fur trade, such as fox and martens are common. Domesticates are absent from these layers associated to the late Mesolithic (Radić 2006).

Vela Spilja appears to have been used both for habitation and occupation during hunting and marine resource seasonal expeditions. Three child burials have been associated with the later Mesolithic occupation. Charcoal recovered 60-80cm above these graves were dated to 6150 BC, suggesting that these burials were associated with the pre-Neolithic occupation. The graves themselves show the articulated bodies of the 2-3 year old children in contracted positions. Furthermore, charcoal samples have been taken from Mesolithic strata (depth of 505cm) suggesting Mesolithic ages of 7380 – 7080 BC (Radić 2006).

A synthesis of archaeological material from Dalmatia was conducted by B. Bass (1997) for his doctoral dissertation. Several radiocarbon dates were recalibrated, and consequently displace some of the previously identified late Mesolithic dates of Dalmatia with later Neolithic ages (B. Bass 1997, ch. 7). Additionally to Vela



Spilja, the site at Crevena Stijena is thought to represent the Mesolithic-Neolithic transition through both occupational phases. It contains well preserved stratification, although no radiocarbon determinations have come from this site which produced microlithic tools and back bladed crescents directly underlying the early Neolithic cultural Deposit (B. Bass 1997). Along with the inland site of Odmuť, Crevena Stijena and Vela Spilja are the only Mesolithic sites in the region to have been excavated extensively (Radić 2006). Additionally, Mesolithic finds from Kopačina Spilja, a cave on the island Brač, have produced finds similar to those from level IV at Crevena Stijena (B. Bass 1997).<sup>51</sup>

### **3.3.3 Mesolithic Evidence from Northeastern Italy: Karst & Sub-Alpine Sites**

In northern Italy, Mesolithic villages differ from later Neolithic villages both spatially and in terms of material remains. Mesolithic sites from northern Italy mainly come from karst cave sites, and high-elevation sites of the Adige Valley and over half of the 54 known Castelnovian sites are found between 500m and 2000m above sea level (Biagi 2003). These are made up mainly of light scatters of surface finds. Less than a quarter of all known late Mesolithic sites in northern Italy have been excavated. Furthermore, several problematic elements remain in defining the late Mesolithic of northern Italy. Of the limited sites excavated, many lie at high altitudes and are generally considered seasonal, short-visit hunting camps (Biagi 2003). Stratigraphic sequences from Mesolithic occupations of camps and caves are found to have sedimentary breaks, which remain a mystery. The question of the subsistence economy of the final hunter-foragers of the alpine region persists. Biagi suggests that this difficulty is the result of soil conditions at high-altitude base camps, inconducive to preservation. Local flint, which does not yield much information about mobility or cultural diffusion, was commonly used by Castelnovian groups. There is no evidence of Mesolithic group's impact on the vegetation or environmental records of the region in question (Biagi 2003).

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<sup>51</sup> Mollusks sampled from the layer just above the "late Mesolithic Horizon have been used to provide the "*terminus antequem* for the underlying Mesolithic stratum" (B. Bass 1997, 65).

The Adige Valley has been suggested a suitable area for studying fauna found in rock shelters. Clark (1990) cites the Mesolithic sites of Pradestel, Romagnano, Dos dela Forca and Riparo Gaban at which butchery processing activities took place as such examples. Later Neolithic finds of pottery and domesticated animals were also recorded from these locations. These sites show continued seasonal hunting operations and are thought to have been satellite hunting camps used as butchery locations where meat and hide would be processed before returning to a primary occupation site (Clark 1990).

Vacamonica, Valtrompia and Valsabbia watershed sites in the southern Italian Alps have yielded radiocarbon determinations (Biagi *et al.* 1995), which aid in establishing the absolute chronology of tool typology and human activity during the early Holocene. Valmaione 1 includes hypermicrolithic flint assemblage, backed points, and backed blades from the Sauveterrian preboreal camp (Biagi *et al.* 1995). Valmaione 2 has yielded two periods of occupation from the preboreal Mesolithic and early Atlantic Castelnovian. The early Mesolithic (Sauveterrian) occupation has been dated to 8700 BC (9410±80 BP, GrN-20093) and 9010 BC (9630±100 BP, GrN-20890) by association with debitage of flint production of hypermicrolithic triangular armatures chipped from allochthonous flint. The Boreal sites at Rodeneto were dated to 8000 BC (8880±150 BP, GrN-1959) using charcoal from a small fireplace surrounded by lithic scatters. Floral analysis based on the charcoal remains, Biagi *et al.* have determined this a summertime occupation. The late Mesolithic Castelnovian camp at Laghetti Del Crestoso is characterized by fireplaces, pits and possible evidence of post holes, which may suggest temporary dwellings (Biagi *et al.* 1995).

### **Mesolithic sites of the Triestine Karst**

The limestone hills of the Triestine Karst range from 100m – 900m above current sea level. The majority of the area is composed of low rounded hills and plateaus between 300m and 500m above sea level. This area is composed mainly of limestone, although two flysch belts, approximately twelve kilometers in width,

cross the area (fig. 3.1). Ash and finely dispersed organic material has been recovered from Mesolithic deposits, indicating intensive occupation of karstic caves primarily in the early Mesolithic (Boschian & Montagnari-Kokelj 2000). The Mesolithic industries at Grottes (Caves) Azzurra, dell' Edera, Caterina, and Lonza have been extensively studied (Biagi 1993, 2003; Boschian 1993; Boschian & Montagnari-Kokelj 2000), though not all of the early Neolithic material found at these sites has been published. During the early Mesolithic, it appears that the karst became highly populated, possibly due to the rising seas and the shrinking Adriatic Plain. The late Mesolithic, like the early Neolithic in this region is not well documented. In most karstic caves, the Neolithic ceramic starts with the middle Neolithic Vlaška culture during the late 5th Millennium BC (Boschian & Montagnari-Kokelj 2000). However, based on ceramics found in Mesolithic layers, Edera and Azzura caves are possible exceptions (Biagi *et al.* 1993).<sup>52</sup>

#### **Grotta Benussi & Grotta Azzura**

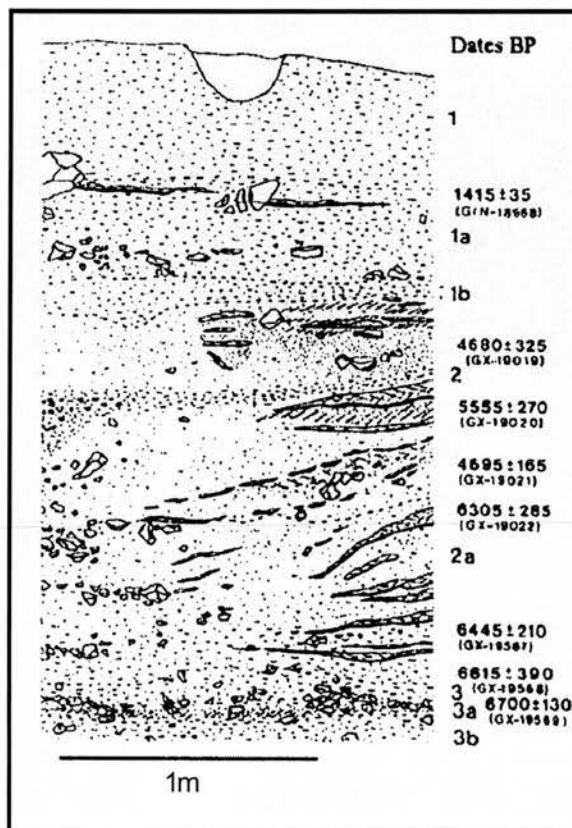
Grotta Benussi was excavated and published by Riedel (1975), and has provided radiocarbon determinations from 7680 BC (8650±70 BP, R-1045A) from layer 5/6. The date and associated faunal evidence have been used by Mlekuž (2005a; see table 2 herein) to suggest domesticates in otherwise Mesolithic layers. Grotta Azzurra was first excavated in the early 1960's and has been used as a point of reference for other karstic Mesolithic deposits and is consequently one of the most important sites on the karst (Boschian & Montagnari-Kokelj 2000). Azzurra also helped define the microlithic component in the flint industry as well as the interruption of the sequence after an early stage of the late Mesolithic. This sequence is based on lithic typology, and has been supported by soil analysis and micromorphological data. The post Mesolithic materials discovered in 1982 "are still unpublished and at present apparently not preserved" (Boschian & Montagnari-Kokelj 2000, 352).

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<sup>52</sup> The theme of 'Neolithic' finds in 'Mesolithic' layers will be discussed later in more detail.

## Grotta dell'Edera: Evidence for Transition?

Grotta dell'Edera was first excavated by Marzolini between 1969 and 1975, and again by Biagi's team in 1991 (Marzolini 1970; Biagi *et al.* 1993). The karstic cave site has produced material spanning from Mesolithic to Roman in age. Grotta dell'Edera is typified by small, fragmented pottery in post-Mesolithic layers. (Boschian & Montagnari-Kokelj 2000). In association with late Castelnovian lithic assemblage, a hearth was discovered during the 1991 excavation of layer 3a (Biagi *et al.* 1993). A single bladelet, and a few trapezoidal shaped lithics, interpreted as projectile points, were recovered in this layer. Layer 3a is also famously known for



its pottery, found in association with these artifacts. This is the only Italian site known at which pottery was discovered in a late Castelnovian complex (Biagi 2003). The radiocarbon determinations from the hearth yielded a date from charcoal at 5620 BC (6700±130 BP, GZ-19569).<sup>53</sup> The assumption of transitional evidence at Edera, however, is difficult to confirm, since the radiocarbon evidence is used to date associate ceramic material which may have been disturbed and perhaps originated from later layers.

Figure 3.10 Stratigraphy from the 1991 excavation season at Grotta dell'Edera (after Biagi *et al.* 1993; Boschian & Montagnari-Kokelj 2000).

<sup>53</sup> A second radiocarbon determination from a mollusk shell (*Patella caerulea*) produced a date of c.6480 BP date as published by Biagi (2003) without sigma.



### 3.3.4 Conclusion: the Mesolithic

Based on evidence from the karst, and northern Istria, it is relatively clear that the *Caput Adriae* was inhabited by seasonal Mesolithic foragers during the time of dramatic climate and landscape change of the early Holocene. Reliance on large fauna appears to have lessened and a more broad-scale diet appears in the later Mesolithic, as evidenced by smaller fauna and a wider variety of species. There is, however, a lack of clear final-Mesolithic and early Neolithic division at most sites which will be discussed. This segues into the discussion of the Neolithization in the region which includes questions regarding populations, migration, adoption or colonization and replacement; this is consistent within the greater archaeological debate regarding the Neolithization of Europe. Within the context of Slovenia, and the eastern Adriatic region however, there are local debates based on a variety of archaeological evidence and theoretical modeling.

Biagi (2003) lists three potential models for Neolithization in the region: indigenism, demic diffusion, and leapfrog colonization. In the case of the *Caput Adriae*, Biagi concludes that the most likely scenario for the region appears to be the demic diffusion model. This is based on the lack of evidence rather than on positive data from the final Mesolithic as seen at Edera and Pupičina Peć. The lack of radiometric evidence of any final Mesolithic sites in the region has thus suggested that the Mesolithic people of the northeast Adriatic disappeared, not simply from the archaeological record, but from the region itself (Biagi 2003). The alternative suggestion, of course, is that sites from the final phase of the Mesolithic have not yet been discovered or fully defined in the region. Biagi concludes the discussion on the late Mesolithic in Italy in his challenge to scholars: “Where are the late Castelnovian hunters and gatherers?” (Biagi 2003, 150).

There have been on-going excavations at Mala Triglavca by the University of Ljubljana in partnership with the University of Edinburgh. However the 2002 – 2005 excavation seasons have yet to yield full post-excavation results. Turk (2004, 208) states the fundamental unresolved question “is how to distinguish Sauveterrian from

Castelnovian or the early Mesolithic from later” sites without well-defined stratigraphy of Mesolithic finds. Similarly, if defining the Neolithic process is important to the Gulf region and the eastern Adriatic, more substantial evidence from the late Mesolithic must be found, excavated, and made available for review. It is extremely plausible that an expansion of subsistence economy and evidence of marine resources from inland habitats, and evidence from the Mesolithic has been submerged by the Adriatic transgressions, and may be underwater or buried under marine sediment; “sea level rise in the early Holocene may have submerged some of the more suitable areas for habitation” (Biagi 2003, 144). It remains a question whether it is possible to contribute to the archaeological record of the Gulf of Trieste and the on-going debate of the Mesolithic-Neolithic transition through underwater archaeological methodology.

### 3.4 Enter the Neolithic

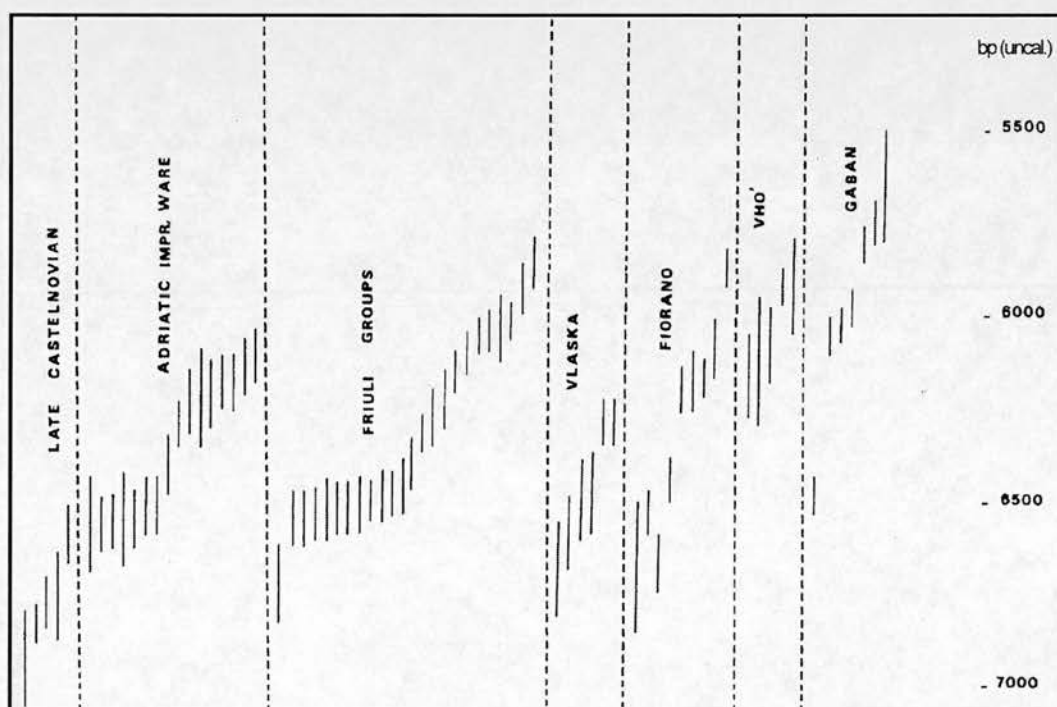


Figure 3.11 Scatterplot of early Neolithic and late Mesolithic (Castelnovian)  $^{14}\text{C}$  determinations from northern Italy (after Pessina & Rottoli 1996). The Castelnovian, Impressed Ware, and Vlaška data are particularly relevant to the discussion of the eastern Adriatic.

As in the case of the Mesolithic, a comprehensive absolute chronology for the Neolithic in western Slovenia and the northeastern Adriatic does not exist, and should be considered a work in progress. Other more developed chronologies are used as a base for interpreting Slovene archaeological sites and material, including the Italian chronology (Turk *et al.* 2004). Thus chronologies from neighboring regions are important to contextualize the evidence from Slovenia (fig. 3.11). Therefore, sites from northern Italy and Dalmatia will continue to be discussed in terms of relevant archaeological material, theories, and chronologies.

### **‘Neolithic’ finds from ‘Mesolithic’ layers: Evidence of Cultural Diffusion?**

As stated, Biagi *et al.* (1993) have published the only ceramics documented in Mesolithic, or perhaps transitional layers from northeast Italy, found at Edera. However, this is not the only evidence from the northeastern Adriatic used by archaeologists to suggest a Neolithic component in Mesolithic sites. Domesticated animal bones have been recovered in ‘Mesolithic’ contexts and have been studied at length by Mlekuž (2003, 2005, 2005b). Mlekuž suggests that the emergence and development of early pastoralism is a signal for the later full scale spread of a domesticated-based subsistence economy that was adopted by indigenous hunter-gatherer communities along the eastern Adriatic coast. Mlekuž (2003) also identified previously published sites as potential examples of such activities along the coast from Montenegro (and further south) to the *Caput Adriae*. Indeed sheep and goat, or ovicaprids, have been recovered in Mesolithic contexts at Grotta Azzura, Grotta Benussi, Podmol pri Kastelcu, Pod Črmukljo, Vaganča Pečina, Crevena Stijena, Odmuť, Vela Spilja, Šandalja, Pupičina Peć, and Grotta dell’Edera (Mlekuž 2003, tab. 1). It also appears that there may have been a transportation route between Pupičina Peć and the karst sites in the early Neolithic (Forenbaher & Miracle 2005). This would have permitted the movement of domesticated animals either for migratory purposes or for trade (Mlekuž 2003).

Mlekuž describes the extent of the cultural and social difference regarding the relationship with animals, and the impact of domesticates in this region. Because

hunting societies do not experience the same ownership rights as pastoralists, owners would have had to protect their herds, ensuring their food supply, and economy. In the transitional period, domesticated animals appear in some hunter-gatherer societies or appear in early pastoral societies along side Mesolithic hunter-gatherers. Thus, the transformation would have been much more complex than a general adoption of ovicaprids. While the animals arrived in the Adriatic fully domesticated, the groups who adopted the pastoralist culture, or traded for the exotic species as prestige items were themselves not Neolithic, nor were they pastoralists during the earliest phase of this transition (Mlekuž 2003).

Site	Context	Date	Ovicaprid NISP
Grotta Azzura	4	Mesolithic	12
Grotta Benussi	5	8380±70 BP R-1045	5
	4	7620±150 BP R-1044	8
	3	7050±60 BP R-1043	9
Podmol pri Kastelcu	13	6610±40 BP Poz-8053	6
		6640±50 BP Poz-8054	
Pod Črmukljo		Mesolithic	1
Vaganačka pečina	1	Mesolithic	??
Crvena stijena	VI	Mesolithic	??
Odmut	I	9135±80 BP Si-2228	??
		8590±100 BP Si-2224	
		7790±70 BP Si-2226	
		7080±85 BP Si-2227	
Vela spila	VII/1998	Mesolithic	6
Šandalja	B/g, B/s	Mesolithic?	??
Pupičina peč	L19-21	6600±240 BP Z-2575	11
Grotta dell'Edera	3a	6700±130 BP CX-19569	53
		6620±60 BP GrA-19912	
		6510±70 BP GrN-27229	
		6480±40 BP GrN-25474	
		6390±60 BP GrN-19820	

Table 3.2 Locations, strata, at which domesticate bones have been found in 'Mesolithic' layers, including radiocarbon determinations when available and minimum number of individuals (after Mlekuž 2003).

The presence of domesticated animal remains in Mesolithic contexts has been critically discussed in other examples of European archaeology. Rowley-Conwy (1995) suggested that similar examples of ovicaprids found in Mesolithic layers in France have been misinterpreted as Mesolithic domesticates. Citing disturbed stratigraphy caused by bioturbation, Rowley-Conwy rejects the thesis that this data might support the claim of pastoralism during the Mesolithic.

Mlekuž's assertions lacks sufficient evidence to be fully accepted until conclusive evidence for domesticates within Mesolithic contexts is produced. Since the



evidence of a Mesolithic association of domesticates exists in a majority of cases, from sites which are defined as 'Mesolithic' only through stratigraphy and typology, Mlekuž's argument is substantially weakened. The notion of domesticates present in a Mesolithic context is best supported perhaps by the case of Edera, layer 3a, which contains both ceramic and domesticated fauna along with Mesolithic type stone tools. This lithic comparison may however be based on lithic type continuity, seen at other sites in the region, namely Pupčina Peć and Sammardenchia. As previously discussed, the results from Edera and other examples used by Mlekuž are likely results of disturbance or migration of archaeological material.

### Defining the Neolithic through ceramic typology

Simplified Chronology of Neolithic Ceramic Cultures					
	ITALIJA	DALMACIJA	CENTRALNA BOSNA	PELAGONIJA	SRBIJA
ENEOLIT	ENEOLITICO	LJUBLJANA NAKOVANJ	VUČEDOL KOSTOLAC		BUBANJHUM
MLADI NEOLIT	DIANA BELLAVISTA	HVAR II/III	BUTMIR III		VINČA D1
	DIANA I SERRA D'ALTO	HVAR I/II	BUTMIR II		VINČA C
	CAPRI II (RIPOLI) SCALORIA	HVAR I DANILO IV	BUTMIR I	UŠTJE NA DRIM	VINČA B2
SREDNJI NEOLIT	CAPRI I SCALORIA	DANILO III	KAKANJ III	TRNSKA TUMBA REŠTANI	VINČA B1
	CAPRI (ADRIATICO) II	DANILO II	KAKANJ II		VINČA A2
	ADRIATICO II/III STENTINELLO II LA QUERCIA	DANILO I	KAKANJ I PROTOKAKANJ		VINČA A1 STARČEVO III
STARJI NEOLIT	ADRIATICO I CARDIUM-IMPRESSO II	CARDIUM-IMPRESSO III/II	STARČEVO-IMPRESSO II STARČEVO-IMPRESSO I	VELUŠINA PORODIN	STARČEVO IIb DONJA BRANJEVINA Ib

Figure 3.12 A Classic chronology from Yugoslavian Neolithic, including simplified Italian and Dalmatian chronologies (after Benac 1979).

### 3.4.1 Early Neolithic of Northern Italy: Karst, Sub-Alpine & Friuli Plain Sites

Pessina & Rottoli (1996) adopt the integrationist argument in regards to the Neolithization of northern Italy. Due to the absence of agricultural activity in the archaeological record, and the lack of a well documented record of late hunter-gatherers in the region, lithic assemblages have been used to express typological dating of sites based on their characteristics. Microburin techniques, microliths and geometric tools, typically associate as Mesolithic, have been suggested as evidence of the development of early Neolithic cultural groups from Castelnovian origins. Pessina & Rottoli cite the Vho, Fiorano, Fagnigola cultures as examples of fully Neolithic communities wherein diffusion would have played a role in the Neolithization of the respective areas of northern Italy (fig. 3.13). This is evidenced through exchange, seen through greenstone from the alps, and non-local pottery, as well as similarity in ceramic production (Pessina & Rottoli 1996).

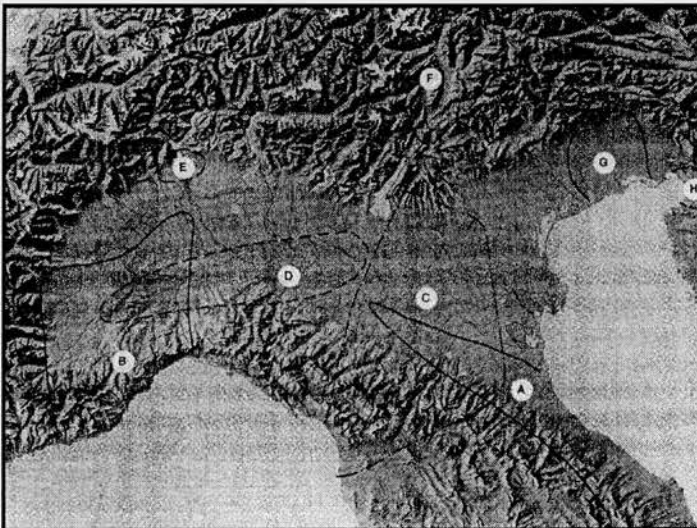


Figure 3.13 Distribution of early Neolithic groups in northern Italy (after Pessina & Rottoli 1996). A) Adriatic Impressed Ware B) Ligurian Impressed Ware C) Fiorano D) Vho E) Isolino F) Gaban G) Fagnigola and Sammardenchia H) Vlaška.

At Piancanada, Palazzo dello Stella, Udine, the Neolithic settlement provided the date 5660 BC ( $6751 \pm 108$  BP, R-2705). Lithic material was discovered, and interpreted to represent a manufacturing workshop and hide working center. Cattle breeding and farming were also represented as widespread activities (Pessina & Rottoli 1996). A stockade, composed of oak stakes driven 1m into the ground, at Lugo di Romagna appears to have been used as a defensive structure. Additionally, a ditch 1m deep and 1.5m to 2m wide implies fortification. It is possible that the

necessity of protecting food stuffs required such defensive structures at this dwelling, which housed cereal storage, and a firing area indicated by a hearth and possible oven (Pessina & Rottoli 1996). The notion of violence in the early Neolithic has been used to suggest not only competition between farming cultures, but also between Mesolithic and Neolithic groups (Budja 1999). In the case of Lugo di Romagna, the dates were likely later than those which would imply direct competition between hunter-gatherers and fully established farming societies. Although it does appear that sub-Alpine hunter-gatherer communities continued to exist during a time of increased domestication in the lower regions. Evidence from the sub-Alpine regions of Brescia, North Italy suggest that the Mesolithic, Castelnovian hunter-gatherers persisted in the high-altitude camps into the early 5<sup>th</sup> Millennium BC, at which the earliest pottery communities first appeared by the end of the 5<sup>th</sup> Millennium BC or beginning of the 4<sup>th</sup> Millennium BC (Baroni *et al.* 1990).

The Friuli Plain was the subject of regional study, which revealed a concentration of Neolithic sites including structures and stone tools (Pessina & Rottoli 1996). Neolithic tools made from greenstone from the western Alps are present at Sammardenchia, in the central area of the plain. This shows a distribution of several hundred kilometers. Pottery examples from Sammardenchia are similar to those found in Vlaška/Danilo groups from the eastern Adriatic (Pessina & Rottoli 1996, fig. 6) and were described as decorated with incised lines, curve-linear motifs and spirals. Pessina & Rottoli relate the early Neolithic ceramics from Sammardenchia to other early Neolithic groups, including those from the Po area. Lithics from this site include endscrapers, borers, rhomboids, microburins, sickle blades and polished stone axes (Pessina & Rottoli 1996, fig 4). The nearby site at Piancada has exposed two lithic workshops and has structures dating to the end of the 5<sup>th</sup> millennium BC. There is also the burial site of a young girl, associated with grave goods of vessel and seashells.

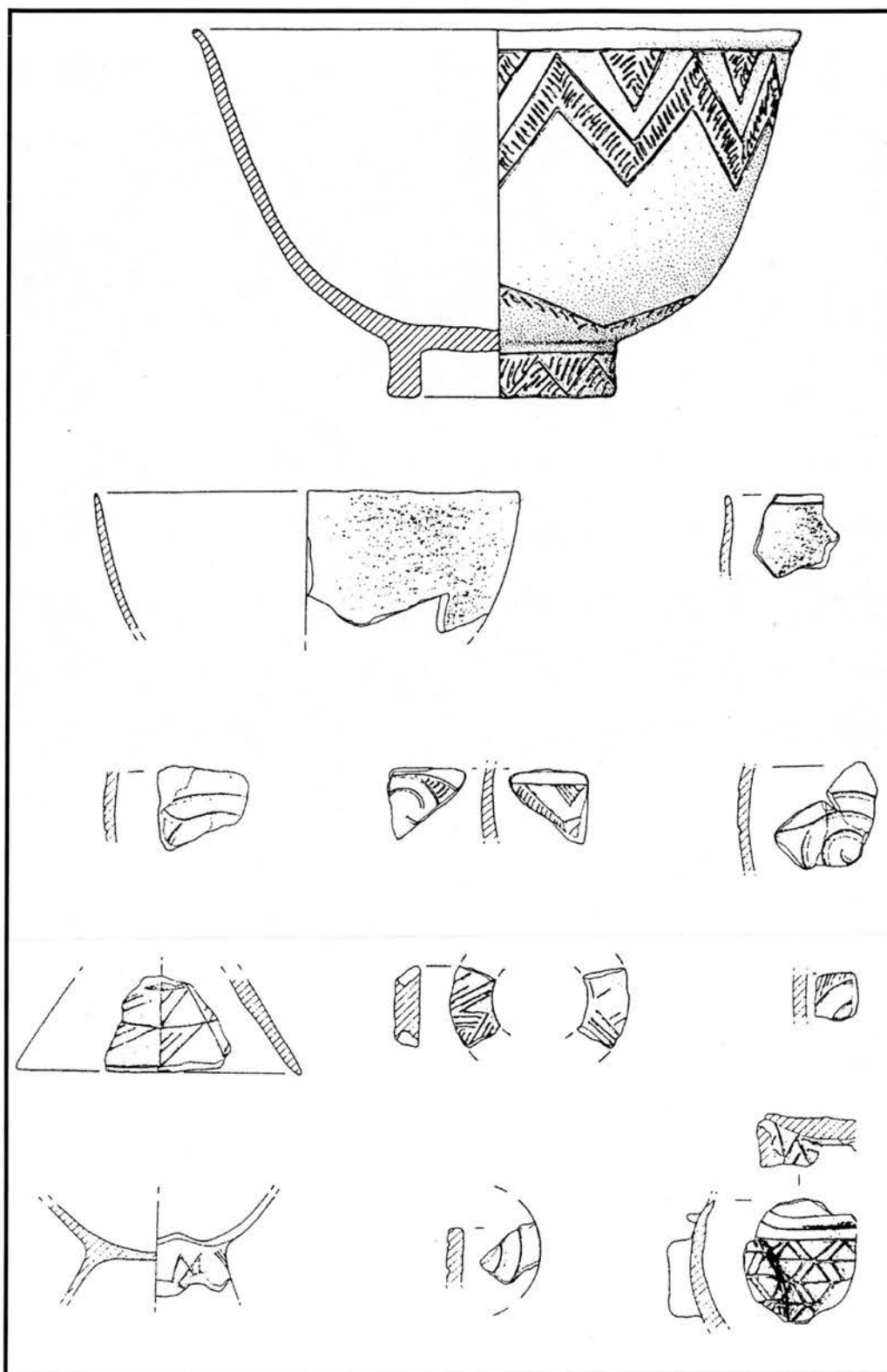


Figure 3.14 Neolithic ceramics from Sammardenchia, Friuli Plain, northeastern Italy (after Pessina & Rottoli 1996).



### 3.4.2 Impressed Ware (*Impresso*) Culture

The distribution of ceramics along the eastern Adriatic is an important indication of the spread of Neolithic economy in the region (Chapman & Müller 1990; Müller 1994). Only isolated Impressed Ware sherds are located in the Karst itself; with a majority of the known evidence discovered at Pejca v Lašci. This evidence has been called into question and dismissed by Forenbaher *et al.* (2003) who state that the identification of the material is questionable. The remaining Impressed Ware sherds are said to come from isolated finds cave sites on the Karst. Yet, there does not appear to be a clearly defined Impressed Ware layer at Edera (Biagi *et al.* 1993) nor the Karst area itself (Forenbaher *et al.* 2003), since the ceramics from Edera are indistinguishable typologically (and are perhaps Monochrome Ware). The cave sites on the northern Dalmatian islands at Vela Spilja on Lošinj island, Jamina Sredi on Cres, and Vorganska Peć on Kirk all possess evidence of Impressed Ware (Batović 1979), but most sites from this region of northern Dalmatia are poorly documented (B. Bass 1997), and lack absolute dates to accompany these finds.

The Impressed Ware culture of the eastern Adriatic is divided into three sub-categories (B. Bass 1997): Impresso A, Impresso B, and Tremolo. Impresso A is defined by simple unconnected stamps, impressions or notches pressed into the ceramic. The impressions can be random, or with “minimal conformity” and “tend to be uneven” (B. Bass 1997, 67). Impressed Ware B has more patterning, either of a linear or of a grouped motif of impressions. Finally, Tremolo is identified by the “tracked or connected tremolo lines” pressed into the ceramic (B. Bass 1997, 67).

### 3.4.3 Early Neolithic Cultural Migration of the Eastern Adriatic

Due to the lack of an absolute chronology in western Slovenia, not only must available data be carefully scrutinized, but the late Mesolithic and early Neolithic of the Karst and Istria must be contextualized within the greater eastern Adriatic region. Chapman & Müller (1990) analyzed 16 radiocarbon dates associated with ceramics from Dalmatia and the eastern Adriatic, including sites from the Karst. The

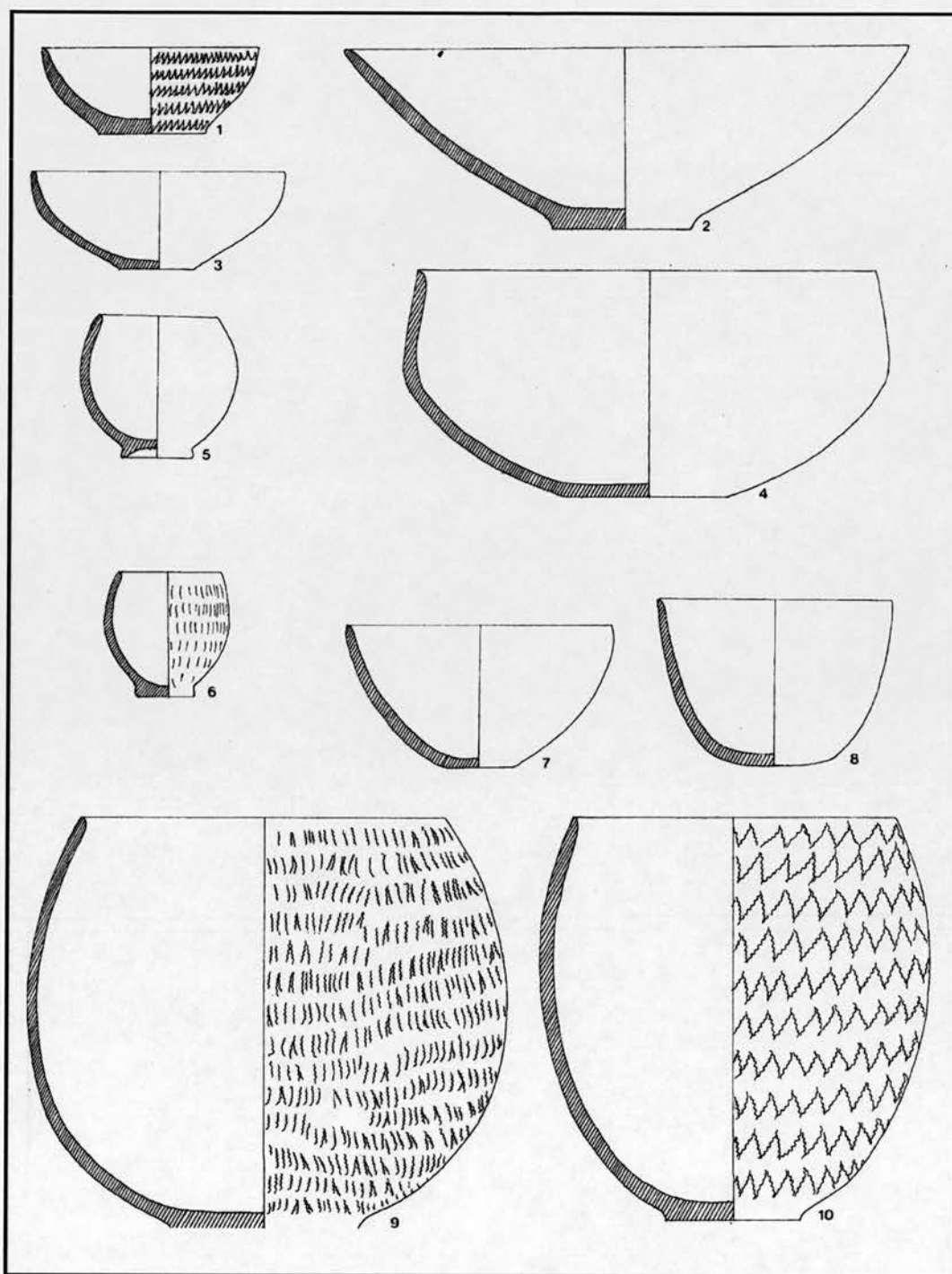


Figure 3.15 Impressed Ware from the *Jadranska Zona* (after Batović 1979).

lack of Impressed Ware, and thus early Neolithic evidence, from the karst environment has led Chapman & Müller to suggest that Istria remained a hunting or Mesolithic refuge zone into late 6<sup>th</sup> Millennium BC. This suggestion was based on comparisons with karst sites and the taphonomy from Odmuť, levels 1a-b (Marković 1985). This has been contested by new evidence from sites in Slovenia (Budja 1996), and Croatia (Miracle 1997). Some of the evidence used to counter this postulation will be addressed herein.

Mlekuž (2005) suggests at least two different processes of Neolithization along the eastern Adriatic, affecting numerous cultures. The first is an integrationist approach, whereby the established communities of hunter-gatherers adopted innovations from an external source. This is illustrated by prestige, or exotic, items including domesticates and pottery. In particular the evidence from caves, previously occupied by people during the Mesolithic, suggests they are used as animal pens in the Neolithic (Boschian & Montagnari-Kokelj 2000; Mlekuž 2003, 2005), which supports the notion that sites were used differently in the Neolithic, opposed to an outright lack of intensive Neolithic occupation all together.

The second possibility of the Neolithization process suggested by Mlekuž (2005) is the establishment of open-air Neolithic sites, which began along the eastern Adriatic coast and was established in the Gulf of Trieste by 5600 BC (Mlekuž 2005; Forenbaher & Miracle 2005). In this model, open air sites occur before the cave sites. These communities appear to be similar to the Neolithic of Greece and the southern Balkans, and would suggest a migration model from a so-called donor area. However Mlekuž argues that pottery and domesticates emerged before the large-scale establishment of Neolithic villages (open-air sites), concluding that hunter-gatherers must have participated in the exchange and diffusion of culture. Furthermore, Mlekuž argues that an explanation of population replacement through migration is overly simplistic.

In 1992, a team of Croatian, Canadian, and British researchers began a two-year investigation of the role of the central Dalmatian islands in prehistory from 8000 years ago to historical times (Forenbaher *et al.* 1994). The islands of Hvar, Vis and Palgruža (fig 3.17) were studied for settlement data, trade and long-distance contact within the larger region. Much of the research concentrated on Hellenistic and Roman material; prehistoric material was discussed, and has since become a focus in the central Adriatic and Dalmatian regions (Forenbaher & Miracle 2005; Forenbaher & Kaiser 2005). While the finds from Vis were mainly Hellenistic and later, and the Impressed Ware finds from Palgruža have been discussed for their contributions in early Neolithic migration patterns, the Island of Hvar has yielded mainly middle and late Neolithic evidence, which has impacted the study of the region. Notably, the Hvar culture, which represents the late Neolithic along the eastern Adriatic (Batović 1979), is defined by the late Neolithic painted ware (fig 3.23), which endured a thousand years on this Dalmatian island.

Forenbaher and Miracle (2005) cite the Greek island of Corfu, and the initial appearance of pottery at Sidari 6500 BC (Perlès 2001), as the donor area for the emergence of ceramics in the eastern Adriatic. Over the span of a few hundred years Impressed Ware is spread northward, reaching Istria by c.5750 BC. Additionally, by 5600 BC, a different style, known as Danilo (or Vlaška), was introduced and appears to have replaced Impressed Ware (Forenbaher & Miracle 2005, fig. 1). Rate of ceramic migration is measurable, containing a longer period between its appearance in central Dalmatia and its arrival in Istria, after a relatively fast spread through the southeast Adriatic. It is probable that ceramics arrived from Corfu through the straits of Otranto to central Dalmatia between 6500 – 6000 BC. This is indicated by Layer C at Sidari, Corfu, which contained Impressed Ware pottery dated to 6200 BC (Perlès 2001; Forenbaher & Miracle 2005, fig.1) representing the era in which pottery began to move northward in the region.

It is not yet possible to determine the cultural identity of the ceramic users: whether the population had changed, or if the cultural knowledge was simply adopted. The coastal distribution however tells of the maritime communication and seafaring



requirements necessary to reach islands in the central and Adriatic (Forenbahe *et al.* 1994; Forenbahe & Kaiser 2005). Nonetheless, Forenbahe & Miracle (2005) do not rule out the notion of prior seafaring during the Mesolithic. Citing seafaring evidence from Franchthi Cave in Greece, along with deep-sea fish procurement and Mesolithic colonization of Corsica and other islands, Forenbahe & Miracle (2005, 523) state that “without more information about the late Mesolithic in the coastal region, it is difficult to exclude an alternative hypothesis that local Mesolithic foragers acquired pottery and other innovations, and then dispersed them by sailing up and down the Adriatic.”

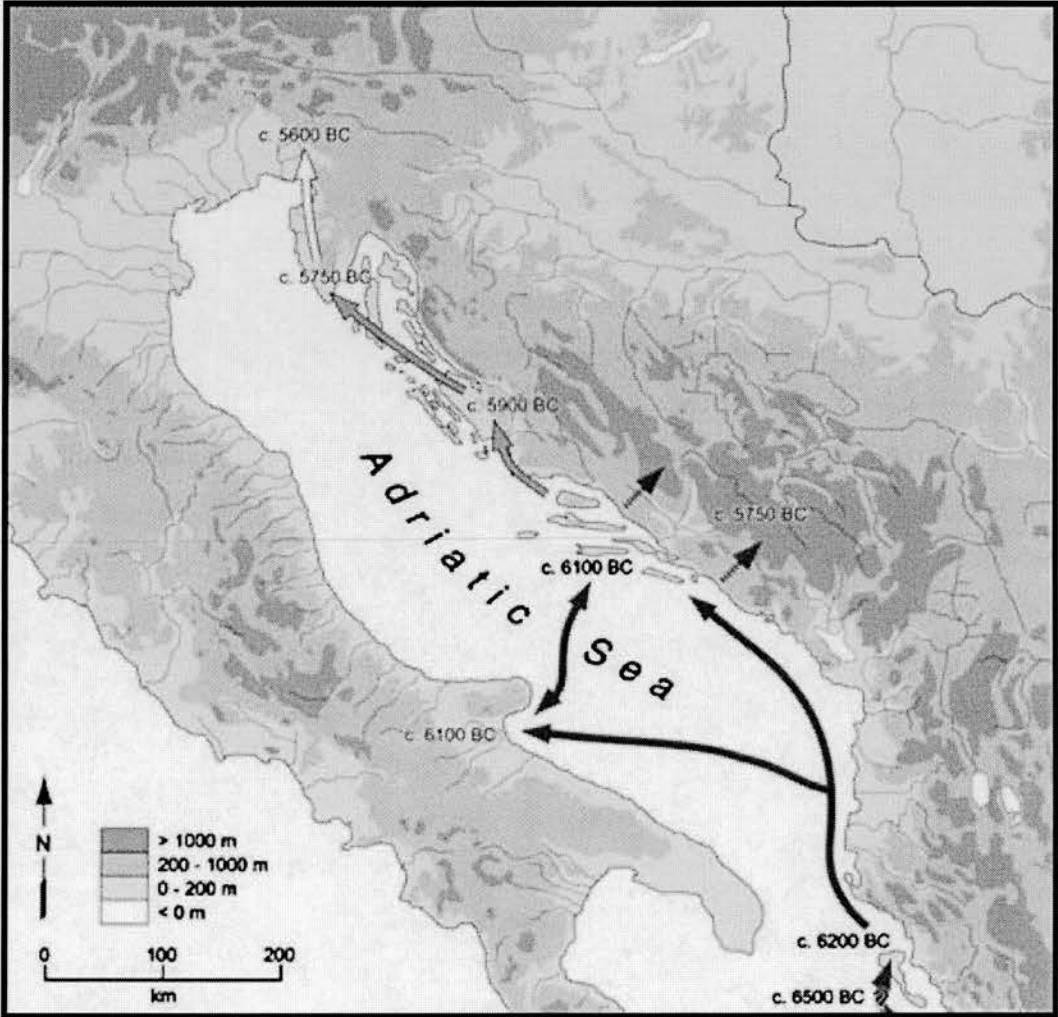


Figure 3.16 Regional distribution of Impressed Ware Ceramics and the earliest known dates thereof throughout the southern and eastern Adriatic (after Forenbahe & Miracle 2005).

## Early Neolithic seafaring and the Adriatic

Material from the central Adriatic islands of Palagruža is seminal in illustrating the importance of seafaring and migration routes of cultures and people of the early Neolithic (Forenbaher *et al.* 1994; Forenbaher & Kaiser 2005). Impressed Ware pottery was recovered near the eastern end of the larger of the two small islands. Palagruža are surrounded by deep water, and would thus have existed as islands during the early eras of the Adriatic. Four sherds from two Impressed Ware vessels are used as evidence to suggest that this island would have constituted an important stopping point for the early Migrations across the Adriatic Sea. Neolithic type flint tools also reinforce the claim for this early Neolithic occupation. Additionally, their source location at Mala Palagruža (*Small Palagruža*) supplies evidence of their quarry. The islands have no standing water, and hence must have been a transit destination for the prehistoric seafarer, en route to the next visible body of land. Because the two islands of Palagruža are central in a chain of islands, and are visible from one to the next on a clear day, ancient sailors would not have needed to travel far from visible land, and could follow currents and winds. The regional migration of pottery and known presence of domesticated animals on the islands implies that the sea was the primary route, and that at least some of these migrating peoples had sufficient seafaring skills and the necessary technology to make such a journey (Forenbaher & Kaiser 2005).

A recent contribution on *Early Seafaring and Social Action* (Farr 2006) has discussed suggested routes (fig. 3.18) based on distance, currents, winds and the presence of islands in the central Adriatic. Farr suggests that “the knowledge and skill needed for this open water crossing may have been different from that needed to make local coastal trips within site of familiar land” (Farr 2006, 93), and the notions of distance and time should be reevaluated in the study of early maritime travel. Farr also suggests that the Neolithic groups traveling by sea would have had an understanding of the seasons based on weather and winds, as well as knowledge of tidal activity, suggesting an understanding of lunar cycles.

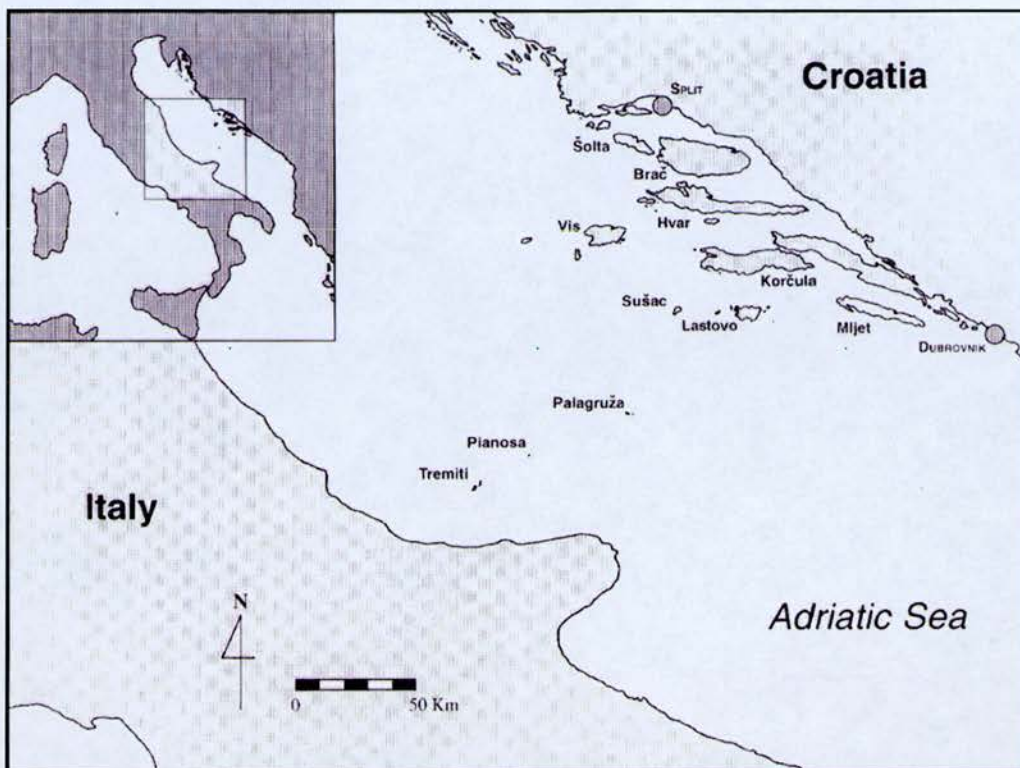


Figure 3.17 Map of the central Adriatic and southern Dalmatian Islands. Palagruža, in the middle has yielded early Neolithic finds including stone tools and Impressed Ware Ceramics (after Kaiser & Forenbaher 1999).

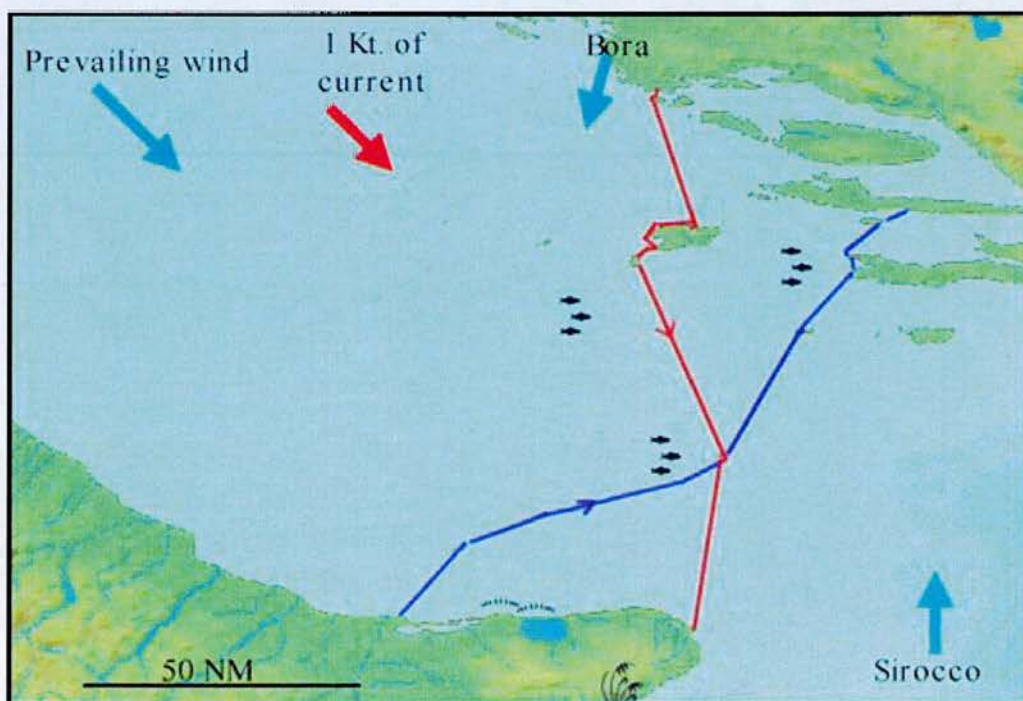


Figure 3.18 Proposed routes of migration based on wind and currents (after Farr 2006).



### 3.4.4 Early Neolithic Cave and Open Air Sites of the Eastern Adriatic

Settlement patterns have been studied for their importance in recognizing the transition to farming along the eastern Adriatic (Chapman & Müller 1990; Müller 1994) and used to suggest the importance of differing social structures (Mlekuž 2005). The preference for open air sites in the early Neolithic appears to be similar to the early Greek and central Balkan Neolithic villages situated in lowland environments suitable for fertile soils, crop cultivation and the ability to yield large quantities of ceramics and domesticates (Mlekuž 2005). This is in sharp contrast to the archaeological record from the early Neolithic use of cave sites.

Soil analysis of chemical and biological remains, from the Neolithic layers of the karstic caves suggests that the sites were used as animal pens during the Neolithic (Boschian Montagnari-Kokelj 2000; Mlekuž 2005), since deposits in the Karst caves contain abundant spherulites and phytoliths, which indicate considerable animal presence (Boschian Montagnari-Kokelj 2000). Coupled with the faunal remains of domesticates the evidence, for Neolithic use of caves as animal pens, is bountiful. The sites are also less dense in artifacts in the Neolithic, with a particular lack of ceramic material in comparison to open air sites (Müller 1994; Mlekuž 2005). This is also proved by the lack of lithic finds from Neolithic layers as compared to previous Mesolithic finds from Mala Triglavca (Petru 2004). It is argued that not all cave sites were used exclusively as pens (Fabec 2003). Pečina pod steno, which has yielded a large number of artifacts from transitional layers seems to support this position (Fabec 2003). This site, however, must be called into question as it has been disturbed, and the finds are likely to be out of context.

This duality between cave and open air sites along the eastern Adriatic has been suggested as evidence that the Neolithic along the eastern Adriatic coast is “not a total phenomenon, but rather a mosaic of different social practices. The mosaic of contexts, with different components of the ‘Neolithic package,’ does not yield evidence of ‘One Neolithic’ but is a reflection of the various social practices that existed along the eastern Adriatic coast” (Mlekuž 2005, 20). Classical elements of



Neolithic economy, namely, but not limited to, domesticated animals were fundamental in the transition as hunter-gatherers emerged into pastoralists, and eventual fully-fledged Neolithic societies. Thus, Mlekuž suggests that it is not a single Neolithization event, which took place in the eastern Adriatic, but a complex series of developments.

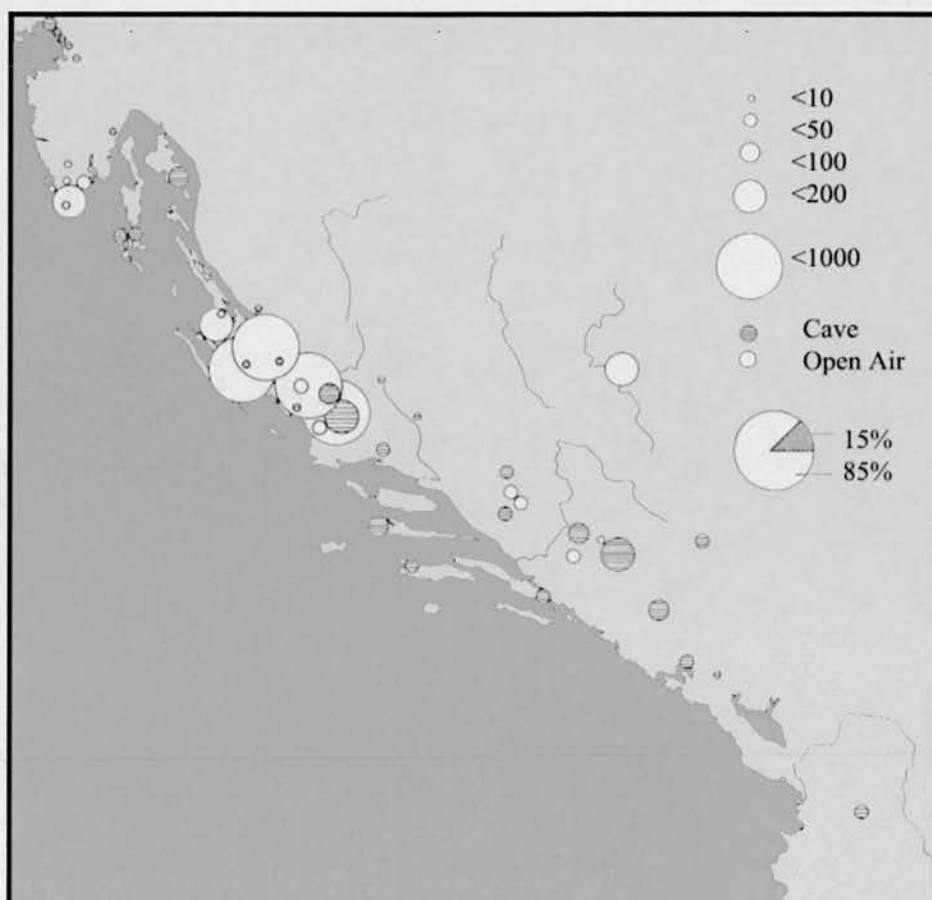


Figure 3.19 Site distribution and total quantity of early Neolithic, mainly Impressed Ware,<sup>54</sup> ceramic finds from the East Adriatic (after Müller 1994). The karstic sites represented in the Gulf of Trieste are slightly misleading as they are not actually coastal sites but rather karstic caves that are located some distance from the sea.

The evidence of Impressed Ware distribution shows that while the technique progressed northwards the people using these ceramics began living in permanent

<sup>54</sup> Note that Müller originally published this map stating that it indicated the distribution of Impressed Ware, though he has included sites from the Karst and Istria which are either questionably Impressed Ware, or, as is the case with Pupčina Peć, decidedly Danilo/Vlaška ceramics. Nevertheless, the map functions to show the quantity difference in distribution of ceramics between open air and cave sites.

villages. This is shown by the open air sites dominated by faunal remains of domesticated animals (Forenbaher & Miracle 2005). The distribution of Impressed Ware along the eastern Adriatic, makes clear that the vast majority of these ceramics comes from open air sites (fig. 3.19). These are interpreted as at least contemporary occupations, in relation to cave sites (Chapman & Müller 1990; Müller 1994), although the open air sites exhibit better land for agriculturalists, and contain a much larger total quantity of pottery finds. This could be interpreted as evidence for earlier occupation of open air sites than of cave sites. Neolithic open air sites appear larger, more developed, and to have existed on more fertile land.

Immigration was a major factor in the introduction of farming in the Adriatic region; and would have included the movement of people, and culture, along with the participation of local populations. "Regardless of whether Impressed Ware was carried by migrating farmers or passed among resident hunter-gatherers, the density and social organization of the late Mesolithic people is key to our understanding of the process." (Forenbaher & Miracle 2005, 524). The need to define the late Mesolithic in the region will be revisited with new suggestions regarding recently developed survey methodology later in this dissertation.

### **3.5 Further Defining the Neolithic**

The Neolithization of the karst, like that of the eastern Adriatic, has been historically defined by the introduction of two cultures, assigned according to their associated ceramic traditions (Budja 1996; Fabec 2003), and by the appearance of domesticates (Biagi *et al.* 1993; Mlekuž 2003). It has been proposed that either the introduction of Impressed Ware culture in the beginning of the Neolithic (e.g. Biagi *et al.* 1993; Fabec 2003), or the later fully established Neolithic Vlaška/Danilo culture (e.g. Chapman & Müller 1990; Velušček 1999) signifies the establishment of Neolithic occupation in the *Caput Adriae*. The onset of the Slovene Neolithic has typically been assigned to the middle Neolithic Danilo culture, and late Neolithic to the Hvar culture (Velušček 1999), based on the established chronology from the Yugoslavian Adriatic zone (Batović 1979). Identifying the very first Neolithic groups in the

region, however, remains ambiguous since the existence of the Impressed Ware culture in western Slovenia remains unconfirmed and the Danilo Culture is typically defined as the first agricultural occupants of the region.

The debate revolves around the evidence, and the question remains whether the fragments of the pottery such as those from level 3a at Edera, and at Pečina na Leskovcu can be seen as a full early Neolithic occupation. Alternatively, it is argued that such data is simply evidence of contact by Mesolithic hunter-gatherers with ceramic making Neolithic people (Fabec 2003). Fabec argues that there is ample data, both from ceramic evidence as well from agricultural data from Abruzzo and Marche on the Karst and Padova Plain, to suggest that the Neolithic culture and subsistence economy did not arrive to the Karst with the middle Neolithic Danilo Culture; but was in the region during the Impressed Ware cultural occupation. Fabec states that “it can be seen, namely, that the start of the Neolithic on the Karst cannot be linked to the middle Neolithic, not in the sense of either the eastern Adriatic or Western Adriatic Neolithic” (Fabec 2003, 109). In addition to objections to certain Impressed Ware dates from Dalmatia, Budja (1996) has also questioned the relationship between Castelnovian foragers and Neolithic agriculturalists who would have existed in the region for a period of 400 years, and the lack of evidence for contact. In nearby Udine, however, violence may be cited as an indication of such a relationship with the Neolithic settlement at Piancandela, at 5660 BC (6751±108 BP, R-2705) (Pessina & Rottoli 1996) contemporary to the transitional dates from Edera.

### **3.5.1 Danilo / Vlaška Ceramic Culture: “Middle Neolithic”?**

Danilo Ware includes incised spirals and other geometric shapes (Batović 1979) and has been compared with Vlaška sites of northern Italy. “In many respects this Vlaška group closely resembles the Danilo group, which we consider a single tradition with a number of regional variants, is sometimes regarded early Neolithic and other times as middle Neolithic, depending on one’s geographical orientation.” (Forenbaher *et al.* 2004). The difficulty concerning the middle Neolithic of the eastern Adriatic, however, is in defining its beginning (Alexander 1972; B. Bass 1997).

Danilo-Bitinj is the type site for middle Neolithic Danilo culture in the eastern Adriatic thought to be the direct descendent of the Tremolo Impressed Ware type (B. Bass 1997). The open air type site northwest of the modern town of Split is only 20 to 30cm in depth of stratified archaeological deposits. Approximately 24 small houses, which were partially paved, were found along with barbed and tanged projectile points and fragments of imported obsidian (Batović 1966; B. Bass 1997). Although there exists an on-going debate over the introduction of this ceramic culture, particularly in the northeast Adriatic, by this so-called middle Neolithic; there is no question that a fully-Neolithic culture and subsistence economy was occurring at the *Caput Adriae* during the time of the Vlaška/Danilo cultural occupation.

Gudnja Pečina, located on the Pelješac peninsula, is also a cave site, which contains Impressed Ware ceramics and is radiometrically dated through charcoal samples (Chapman & Müller 1990). Associated fauna included domesticated caprines, pig, and wild rabbit, mollusks and birds. B. Bass (1997) cites Gudnja Pečina as a possible early-middle Neolithic transitional site, which offers the earliest Danilo evidence in addition to older Impressed Ware material culture. Other Dalmatian islands contain sites, which are important to the regional overview. Vela Spilja contains a very distinctive break in early and middle Neolithic cultures, marked by linear and spiral motifs, light colored surfaces, and paint with red resistant dye, generally burnished red, black or gray with a uniform and glossy surface (Radić 2006). These are suggested, by Radić, as Vela Luka culture, which exhibited great similarity to Danilo style pottery, and included fragments of four-legged Danilo rhyta. Radić also notes the similarity to the middle Neolithic ceramics of the Apennine Peninsula, which suggest cultural migration across the Adriatic. Budja (1993) has questioned some of the dates associated with the early Neolithic at Vela Spilja (layer 1a) dated to c.6100 BC and 5800 BC, and at Gudnja Pečina which has also yielded dates from a ceramic layer (layer 1) dated to c.6000 BC, and 5800 BC. This was originally thought to be problematic due to 'the old wood effect', however these reservations have been



abandoned as evidence has become available, and the dates described are now widely accepted (Mlekuž, pers. com.).

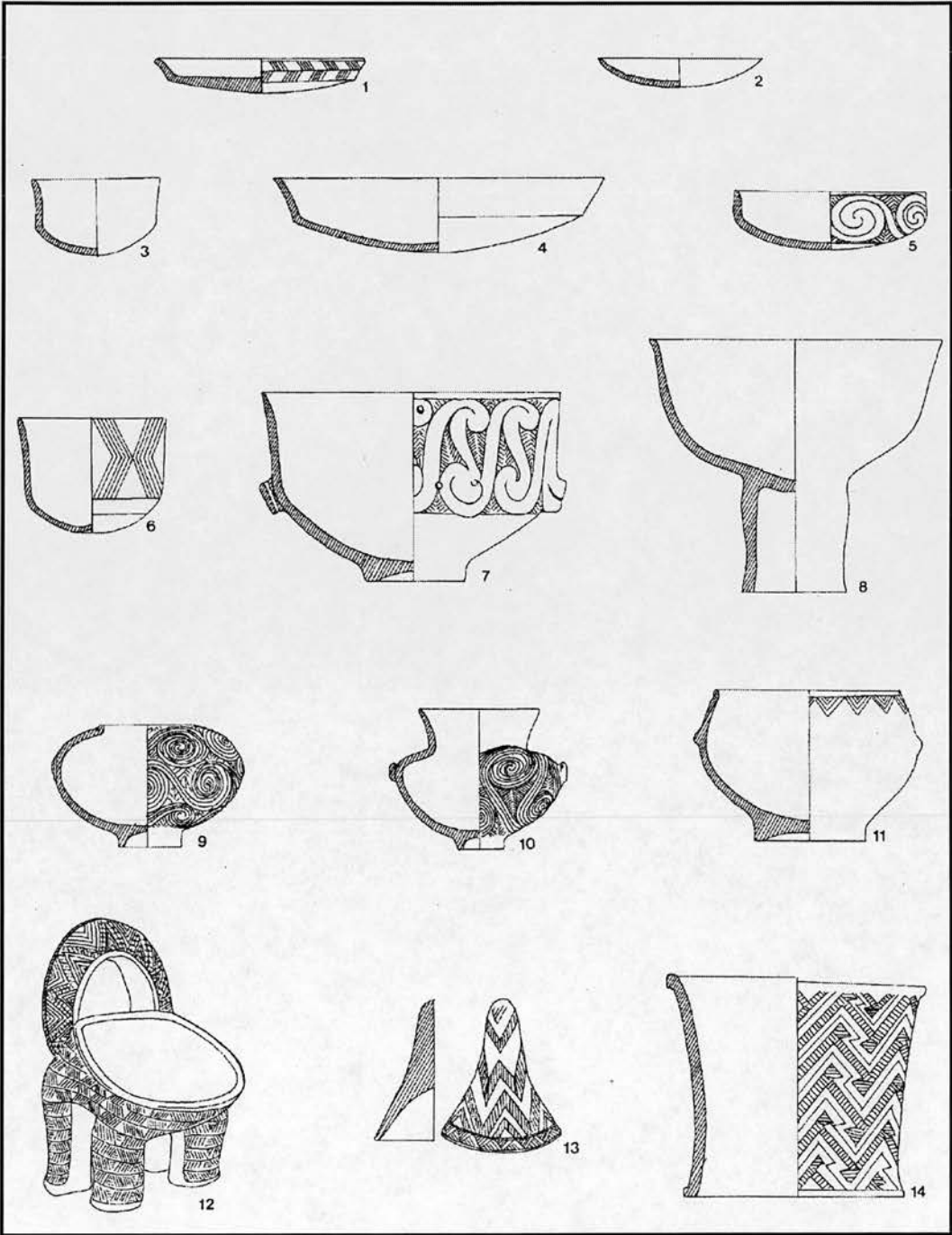


Figure 3.20 Danilo Ceramics from the eastern Adriatic Zone (after Batović 1979). A middle Neolithic type Rhyton, or salt-pod is shown on the bottom left.

### 3.5.2 Neolithic Evidence from Istria: Pupčina Peć, Vižula & Sermin

Pupčina Peć, previously discussed for its early Mesolithic content, has also been studied for its later evidence from the Neolithic, Copper and Bronze Ages, and Roman material (Forenbaher *et al.* 2003). The earliest post-Mesolithic layers from Pupčina were beneath most all of the later features and disturbances and dated radiometrically through ash lenses. Two dates from Neolithic Horizon I have yielded ages from the middle to late 6<sup>th</sup> Millennium BC. Due to the confusing state of ceramic chronology in the northeastern most corner of the Adriatic region, Forenbaher *et al.* determined that the ceramics from this early Neolithic context were most appropriately typologically identified as middle Neolithic. This is based on comparison with finds from Vižula, sites near Pula which contained Impressed Ware in the earliest Neolithic layers, and Vlaška/Danilo representing younger, middle Neolithic occupations.

A lack of a clear reliable chronology for Neolithic pottery sequence in Istria continues to cause confusion in establishing an absolute chronology in Istria. Adding to this confusion, is the fact that these ‘middle Neolithic’ layers at Pupčina are of the oldest middle Neolithic assemblages for the eastern Adriatic (Miracle *et al.* 2000; Forenbaher *et al.* 2003). However, available evidence suggests that the dates from Pupčina Peć do not support the model for Istria as a refuge for Mesolithic hunters proposed by Chapman & Müller (1990), since, according to Miracle (1997), the earliest Neolithic dates at Pupčina Peć range from 5680 BC to 5280 BC. This seems to overlap with other transitional early Neolithic sites of the Gulf region (e.g. Biagi *et al.* 1993). Thus, Miracle suggests that it is the final Mesolithic, which is missing from Pupčina Peć, rather than the earliest Neolithic. This depends on the interpretation of Impressed Ware and Monochrome finds from ‘Mesolithic’ layers. If Impressed Ware is to be considered transitional Mesolithic-Neolithic, rather than a fully defined Neolithic culture, the early Neolithic is indeed missing from Pupčina Peć, which has yielded finds from a fully established Neolithic culture and subsistence economy. The well-defined Neolithic sequence continues at Pupčina Peć, as a single date from the late Neolithic horizon provided a date of 4400 BC, and

later Copper Age layers (Forenbaher et al. 2003) which are contemporary with the Eneolithic in Slovenia.

Tools found in the Neolithic layers at Pupčina Peč show signs of hunting and butchering, as well as hide working, wood working, and combinations of different uses (Petru 2004). Because the Neolithic stone tools do not vary greatly typologically from Mesolithic tools at Pupčina Peč, continuity of culture is implied. Additionally, Neolithic stone tools appear to be similar in function to those of the Mesolithic, with the addition of woodworking in the Neolithic (Petru 2004). This use-wear analysis suggests that Neolithic people at Pupčina Peč were hunters and herders, and continued to carry out some of the traditional activities and tool-making techniques of the earlier Mesolithic occupants. Both typological and use-wear data that express continuity from Mesolithic and Neolithic occupations are important to the notion of transition and material culture. Furthermore, these results can be applied to other sites in the region especially when stratigraphy or tool type has been used to define an occupational phase.

Vižula, dated to as early as 5760 BC (6850±180 BP, HD-12093) (Chapman & Müller 1990), is a large open air settlement at the southern tip of the Istrian peninsula, located near the modern town of Pula. The distribution of Neolithic Impressed Ware pottery in Istria (fig. 3.20) is mainly restricted to the Pula region, which houses the main centers for archaeological research and conservation in Istria (Forenbaher *et al.* 2003). This site, and the corresponding sites around Pula represent the northernmost open air sites with Impressed Ware ceramics along the eastern Adriatic (Chapman & Müller 1990). The early Neolithic Impressed Ware dates from Vižula overlap with the earliest Vlaška cultural deposits from Pupčina Peč (Miracle 1997).

Sermin is the outlier on the map otherwise void of prehistoric sites along the Slovene coast (fig 3.24). This open air site is found near the modern town of Koper, and has produced middle Neolithic, Vlaška/Danilo type ceramics (Snoj 1992). The site is located on a hill by the same name, and is also known as Kaštelir (Horvat 1997).

Finds from the Neolithic, Bronze and Iron Ages are recorded from Sermin (Snoj 1992); which is also known for its later, particularly, Roman finds (Horvat 1997) thought to have been few in number during the initial excavations. The hill has been disturbed by agricultural activity, military building, and the creation of trenches. Neolithic finds were mainly of pottery; and the majority was discovered during the 1990-1991 rescue excavations at this site (Snoj 1992; Horvat 1997).

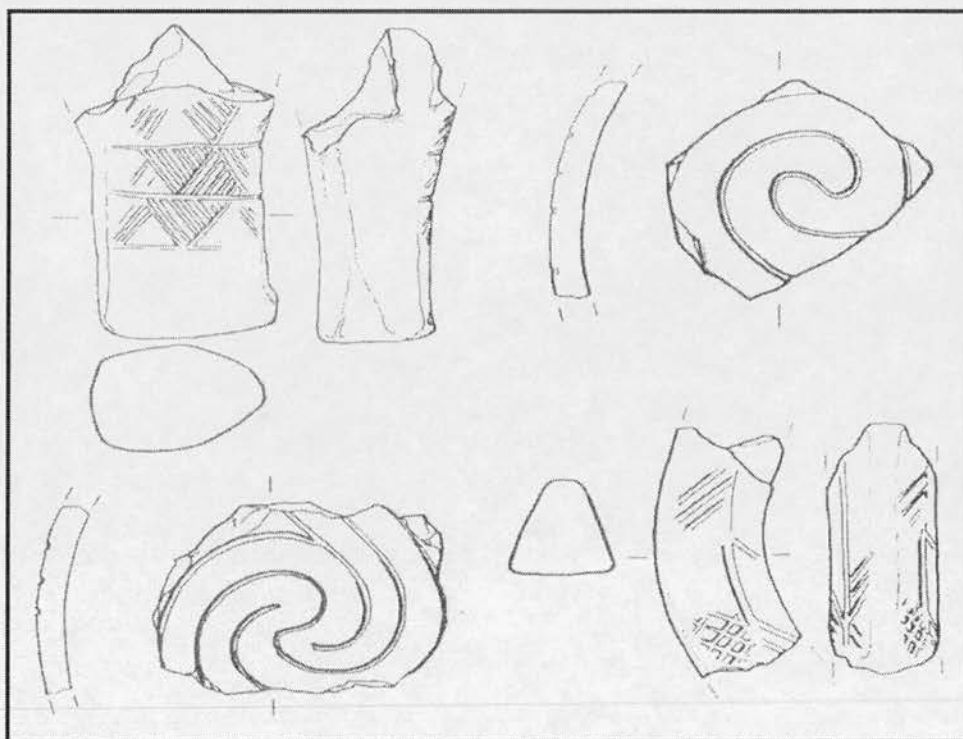


Figure 3.21 Examples of ceramic finds typologically identified as late Neolithic from Sermin (after Snoj 1992) without scale.

Part of the reason for the lack of Neolithic finds on the Slovenian coast is the flysch belt. The overriding difficulty of the flysch region is the composition of the matrix itself. Sites on slopes are often eroded and washed away. In this respect Sermin is an ideal location for archaeological recovery: situated on the slope of a low hill, just above the alluvium, the slope is not steep enough to be washed away (Mlekuž, pers. com.). Thus, Sermin can be seen as a single site, which represents the occupation of coastal Slovenia as far back as the Danilo Neolithic occupation in a region otherwise



lacking evidence of late Stone Age occupation (Mlekuž 2005).<sup>55</sup> A middle Neolithic Rhyton has also been recovered from Sermin (Mlekuž, pers. com.).

### 3.5.3 Neolithic Evidence from the Slovenian Karst

Leben (1988) assigned the Neolithic layer at Mala Triglavca as -2.6m to -3.5m depth. In addition to pottery, a flat stone axe, additional stone and bone tools, and a human skull fragment there exist faunal remains, of which one quarter were domesticates of cattle, sheep/goat, and dog, while the rest were hunted animals, mainly deer (Leben 1988). Since there were few Neolithic stone tools (a total of 16) as compared with Mesolithic (about 800) it has been suggested that Mala Triglavca was not occupied for very long during the Neolithic (Petru 2004). Tools for animal processing were rare, and it appears that either the occupation time was too short to appear in the archaeological record, or that the pastoralists of Mala Triglavca carried out most of their activity elsewhere. Based on the limited quantity of stone tools, and the model of caves used as animal pens (Boschian & Montagnari-Kokelj 2000; Mlekuž 2003) it Mala Triglavca appears not to have been used primarily for human occupation.

Lithic artifacts from Pupčina Peč have been described as typologically similar to Mesolithic artifacts. If there has been questionable assignment of lithic material from Mala Triglavca, as inferred by Velušček, the evidence from Pupčina Peč would suggest that designation of age concerning Mesolithic and Neolithic artifacts is not appropriate. Thus, the ratio of Mesolithic to Neolithic flint artifacts (800:16) could be considered questionable. The lithic evidence may be clarified once post-excavation details are analyzed and become available. Particularly interesting are the three-dimensional positioning of finds based on laser measurements using two Leica Totalstation EDM's which were used in tandem during the 2002-2005 seasons.

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<sup>55</sup> See distribution maps (fig. 3.24 a-d).

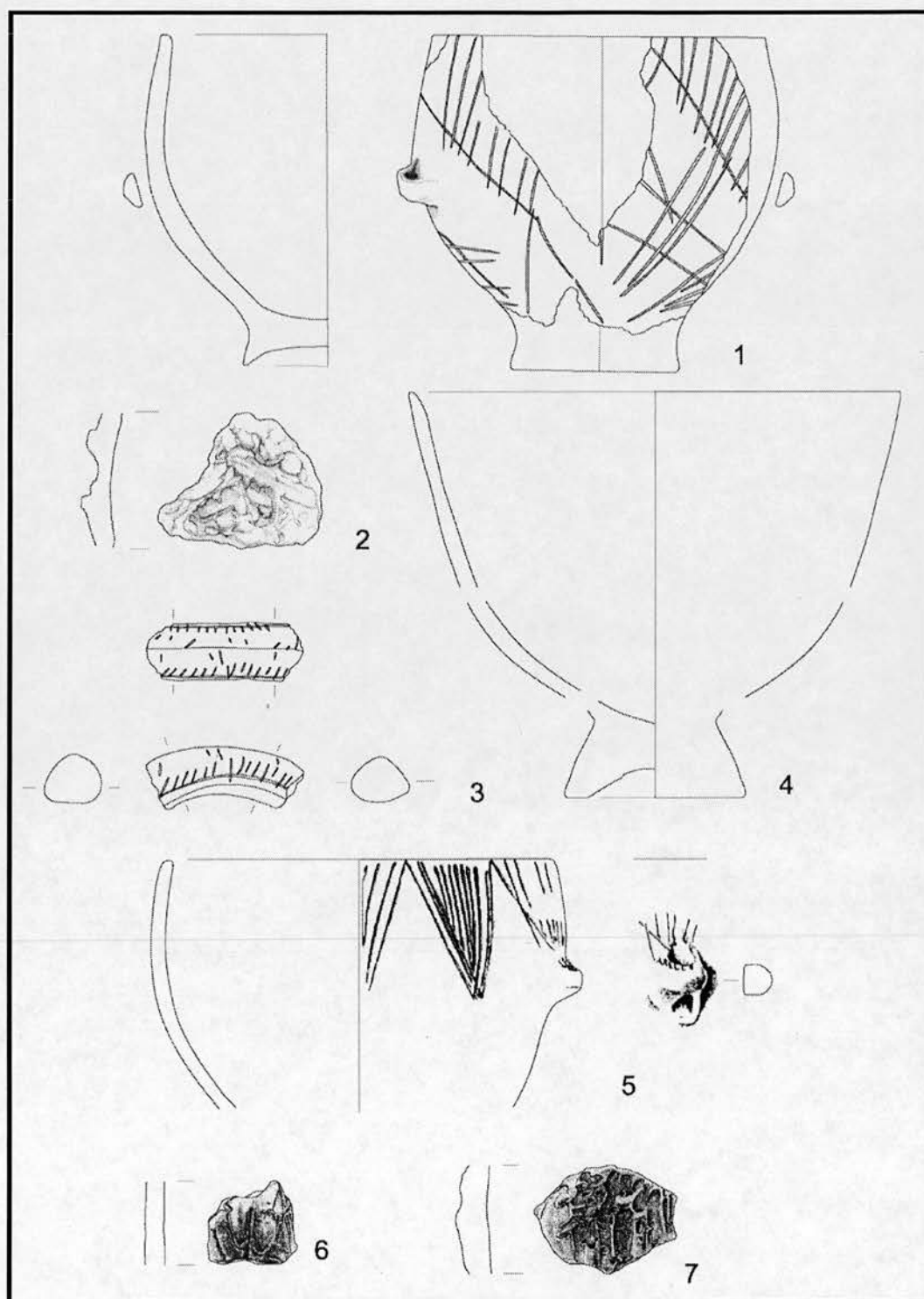


Figure 3.22 Samples of Neolithic ceramics from Mala Triglavca (after Žibrat Gašparič 2004).

Pottery from Neolithic and Eneolithic layers at Mala Triglavca total 690 fragments, of which 24 samples were archaeometrically analyzed (Žibrat Gašparič 2004). It appears that the mainly Danilo/Vlaška style Neolithic was produced locally, using the available material. The results allow for a comparison of Mala Triglavca's Neolithic occupation with the Vlaška layer 2a at Edera (Biagi *et al.* 1993). In each of these sites' Danilo/Vlaška layers, a ceramic vessel known as a Rhyton was found, both seemingly produced locally (Žibrat Gašparič 2004). The Rhyton is a ceramic phenomena associated with the Danilo culture of Dalmatia and suggested to have been used as a salt-pot (Chapman 1988). It has been used to suggest further evidence of a continuous regional cultural migration along the eastern Adriatic during the middle Neolithic (Biagi & Spataro 2000; Mlekuž 2003), although similar vessels were found at sites in Greece (B. Bass 1997). Mlekuž (2003) has even suggested a symbolic comparison in the shape of Rhyta, possibly represent a four-legged domesticated animal.

#### **3.5.4 Neolithic Evidence from the Ljubljana Moor**

Previous attention has been paid to the environmental data from the Ljubljana Moor; however, because of the limited evidence from the earliest Neolithic from western Slovenia, it has been suggested that more data would be necessary to interpret this process in Slovenia, and that such evidence may come from the Ljubljana Moor (Budja 1993). Thus far, however, there have been only scattered Mesolithic or early Neolithic artifacts from this region (Turk *et al.* 2004), which has mainly yielded mainly artifacts from the 4<sup>th</sup> Millennium BC or later (Velušček 1999), instead of those which would represent the early Neolithic sites from the 5<sup>th</sup> Millennium BC. Mlekuž (2006) recently focused on the Iščica floodplain of the Ljubljana Moor, discussing the landscape and settlement dynamics on a local level with regards to specific occupations.<sup>56</sup>

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<sup>56</sup> See Mlekuž 2006 table 1 for most current 14C determinations from the Iščica floodplain.

The earliest material from the Ljubljana Moor was found on Breg pri Škofljici (Frelih 1986). In 1998, a trench exposed a surface in which bones of non-domesticates: boar, deer, and "late Mesolithic" toolkit including trapezes were found (Mlekuž 2002). Pottery was also recovered from this horizon. Several samples were submitted for dating though they did not result in accurate dates due to leached collagen (Mlekuž, pers. com.). This horizon remains undated, although Frelih (1986) published a date from test trench only few meters away with similar material (but lacking pottery) to 5740 BC (6830±50 BP). Turk however, has stated that this date is erroneous, as it is "essentially too recent" (2004, 66) and is thus not associated with the Mesolithic-Neolithic transitional occupation. Furthermore, pottery found at Breg pri Škofljici is thought to have certain similarities with the earliest pile-dwelling in Barje Resnikov prekop (Tomaz 1997) dated to 4720 BC (5856±93 BP). This corresponds with the middle/late Neolithic according to the regional chronology (Mlekuž, pers. com.).

These dwellings have been used to address the question of the earliest late Neolithic and Eneolithic communities of continental Slovenia (Velušček 1999), although Velušček's chronology of the Ljubljana Moor is not accepted without question (Mlekuž, pers. com.). Elsewhere in the Ljubljana Moor, Maharski prekop has been recognized as an early center for copper age metallurgy after a smelting pot including sulfide ore was dated to the 4<sup>th</sup> millennium BC (Velušček 1999). This evidence was used to refute the previous suggestion that metallurgy did not exist in Slovenia until the late Eneolithic. Additional absolute dates from the Ljubljana Moor have yielded Eneolithic ages at Hocevarica where <sup>14</sup>C determinations dated Eneolithic pottery aged to 3600 BC, and Maharski prekop where wood was dated through dendrochronology to 3400 BC (Velušček 1999) and recently by a series of radiocarbon determination to 3540 BC (4740±40 BP, Beta-219606) (Mlekuž 2006, tab.1).



### **3.5.5 Late Neolithic Evidence from Dalmatia: Hvar Culture**

There are at least 17 sites on the Island of Hvar dating from 6000 BC to 4000 BC. Of these, the vast majority (13) are caves, while the rest are isolated finds of lithics or ceramics (Forenbaher 2002). Forenbaher is wary that most of these Neolithic finds are cave sites; believing that these caves were (and are still) used opportunistically and that preservation conditions, combined with survey bias has shown such a skewed proportion of cave sites.

Grapčeva cave was excavated in the hopes of revealing a central Dalmatian post-Mesolithic site to help establish a reliable chronology of the region (Kaiser & Forenbaher 1999). Grapčeva yielded late Neolithic, Hvar Cultural artifacts, dates from the 5<sup>th</sup> millennium BC, and Nakovana finds from the Copper Age 4<sup>th</sup> Millennium BC. Based on evidence at Grapčeva, Forenbaher & Kaiser believe that the late Neolithic in Dalmatia lasted longer than the phases which composed the middle and early Neolithic. The prolonged continual ceramic culture incorporating hemispheric bowls and red-on-black painted decoration, which seemingly lasts an entire millennium (Kaiser & Forenbaher 1999), validates this suggestion.

Hvar culture is strongly represented at Vela Spilja, and identified by its ceramic typology: particularly dark burnished pottery, decorated by incision, grooves, painting, incision outlines (Radić 2006). The most common shapes are simple, carinated and S-profile bowls, spherical vessels with cylindrical necks, oval jars with cylindrical necks, and coarsely made common vessels. At Vela Spilja, progressing Hvar culture indicates a growing importance of cattle and an increase in finely retouched projectiles and other flint tools. Radić suggests that such changes in tool typology indicates contacts or mixing with continental populations. This is particularly true of the later Hvar phases in Vela Spilja. Hvar cultural occupation at Vela Spilja is also considered represented and continual through the early Eneolithic, or early Copper Age (Radić 2006).

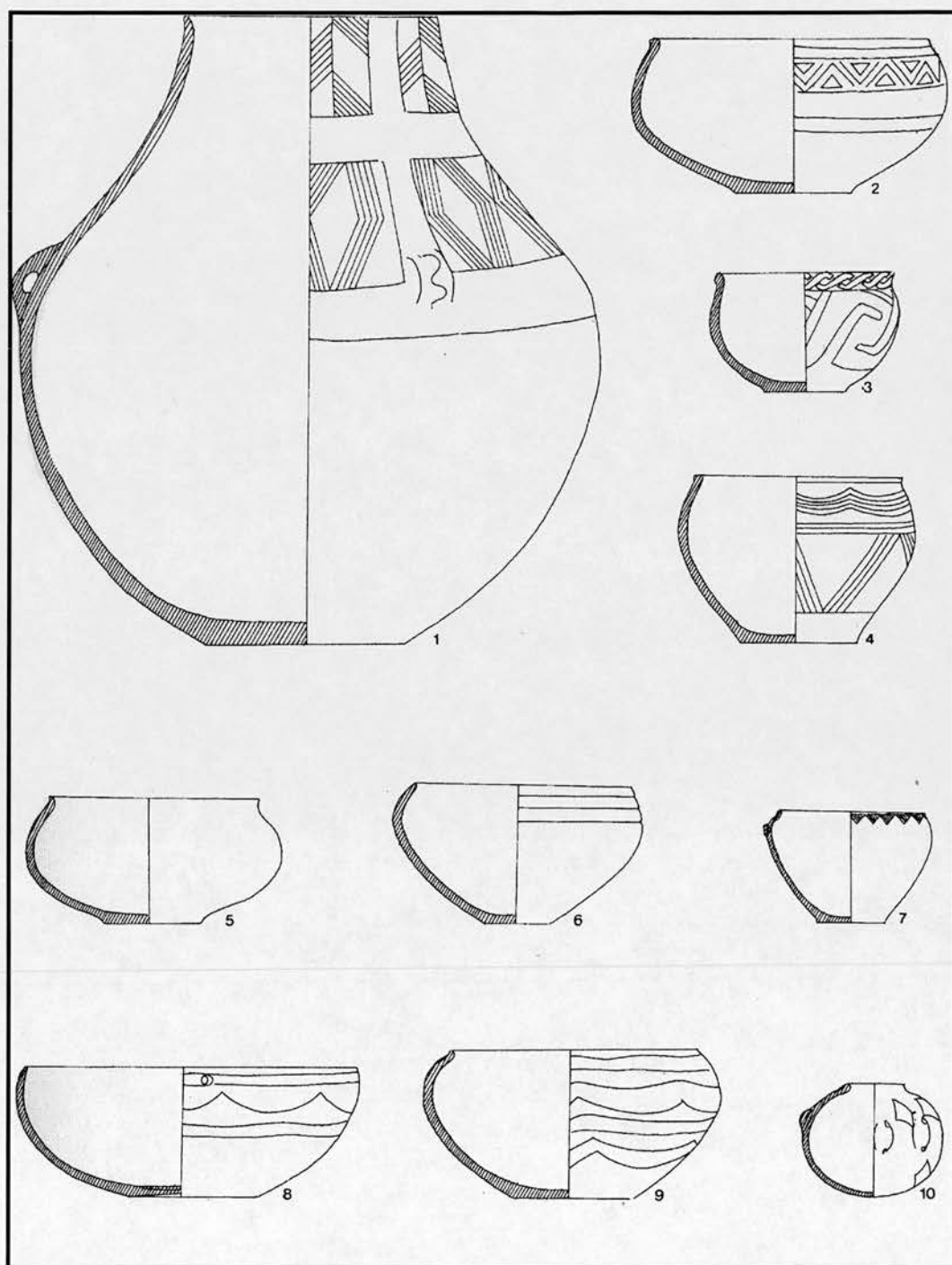


Figure 3.23 Hvar Culture Ceramics from the east Adriatic Zone (after Batović 1979).

### 3.6 Conclusion on the Neolithic of Western Slovenia & Eastern Adriatic

The Neolithic in Slovenia is defined mainly by karstic cave sites, both within Slovenia itself and in neighboring territories. Both Italian and Croatian sites have produced more accurate and reliable chronologies, and more radiocarbon determinations and contains sites with less disturbed stratigraphy. Looking at the karst, and Istria, there is a lack of both late Mesolithic and Neolithic sites, which have been excavated stratigraphically. Additionally, there are few radiocarbon determinations, and thus the absolute chronology in the region is limited. Sites are defined by typology, with layers determined by the existing chronological paradigm. Additionally, there have been multiple cases of sites excavated by questionable methodology. Thus, the resulting picture of the Neolithic transition in the western Slovenia remains vague and incomplete. Elements from the later Neolithic and Eneolithic are evidenced from the Italian sites on the karst, the sites of the Ljubljana Moor, and from other areas along the eastern Adriatic, such as Dalmatia. Recent studies have emphasized the need for radiocarbon determinations for the establishment of local and regional chronologies in Slovenia and throughout the eastern Adriatic (Chapman & Müller 1990; Mlekuž 2005; 2006). More data will allow for such a refinement of absolute chronologies in the region, and thus, site discovery remains important for this region, particularly along the coast of the northeast Adriatic, where a lack of information has been shown to exist.

Sites on the karst, particularly cave locations, are more easily found since rock shelters tend to enable preservation and are obvious indications for potential archaeological discovery. These cave sites represent early stock-rearing and the Neolithization of the *Caput Adriae* region and western Slovenia, because open air sites either did not exist, or were not preserved due to limited remains and erosion (Boschian & Montagnari-Kokelj 2000). Once again, it is evident that a bias exists in the site distribution of the region. The archaeological record is dominated by cave sites and lacks open-air, and coastal sites. It is impossible, however, to state that a total absence of such sites exists without thorough investigation of the region through intensive survey. Velušček (1999) notes the importance of site discovery

that has been based on the automobile highway network, which has created rescue excavations, such as those excavated by Turk at Dragomelj. Turk *et al.* (2004) suggest that research priorities and politics have played a part in the increased investigation of Mesolithic and Neolithic sites in Slovenia. Furthermore, cave sites are dominant in the region because they are obvious locations for archaeologists to search. These modern elements of funding, politics, and priorities play a role in the scientific output of a region, and must not be overlooked in the discussion of the Mesolithic-Neolithic transition (and later prehistoric phases) regarding the archaeological site distribution pattern of the Gulf of Trieste.

Budja (1996) suggests that the Neolithization of Slovenia, could be seen as a transition to farming, which started in different regions with: either the immigration of farmers or pastoralists, and was followed by the spread of these farming communities, or by local foragers adopting farming and colonizing new areas, beginning with the highest quality soils. However, Budja (1999) has also suggested that MtDNA, which differs from the Y-chromosome studies used by Ammerman & Cavalli-Sforza (1984), supports the maritime pioneer colonization model for Neolithization. These views are based on the changing climate of archaeological thought at the turn of the millennium, highlighted by Zilhão (1993) and Zvelebil (2001).

The scenario whereby pastoralism was adopted by local foragers is argued by Mlekuž (2003, 2005) however the data seems at present to be inconclusive and requires more investigation. It is unlikely that the debate surrounding cultural and population migrations and cultural diffusion in the region will be answered without more archaeological material to analyze. This is particularly important in the coastal zone which is presumed to have been the avenue for such population and cultural migration. The trend surrounding the expansion of the Neolithic process throughout the eastern Adriatic revolves around the evidence of domesticates and/or ceramics. These are divided into open air agricultural villages and cave sites used by pastoralists as animal pens. In the case of the western Slovenia, however, if the Neolithization is discussed based solely on data from caves and without reference to



open air sites, it must be demonstrated that the fertile soils of the coastal flysch do not contain earlier agricultural or Mesolithic-Neolithic transitional sites. Such open air sites *should* exist near the coast based on the Dalmatian evidence presented by Müller (1994).

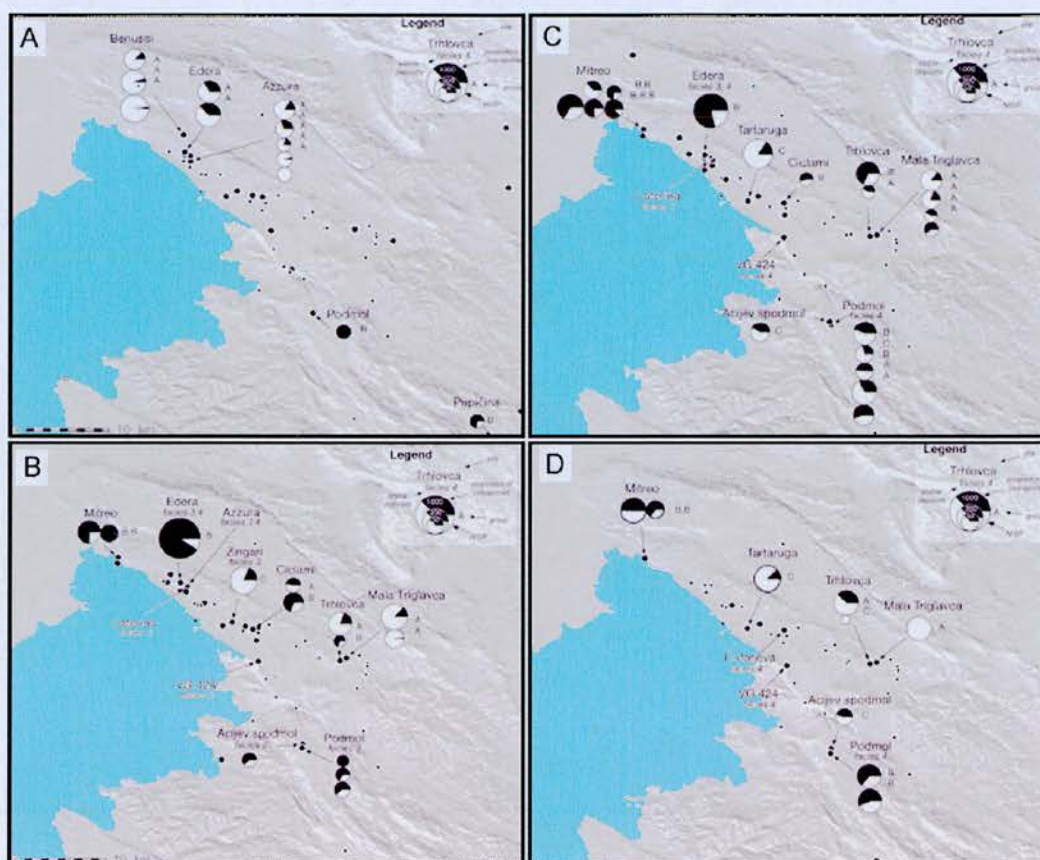


Figure 3.24 Assemblages of domesticated ovicaprines (after Mlekuž 2005) shows the site distribution at the *Caput Adriae*: there is a notable lack of sites on the Slovene coast. A) Mesolithic & early Neolithic B) Vlaška Culture C) late Neolithic D) Eneolithic & Bronze Age.

The flysch of coastal Slovenia is considered the better area for agricultural activity, because more water is available, and the shallow valleys erode in the soft hillsides creating a soil-cover more suitable for agriculture (Boschian & Montagnari-Kokelj 2000). Since agricultural activity cannot be measured in the region's pollen record during the Neolithic and Eneolithic periods (Willis 1995; Gardner 1999), direct evidence is the best method for proving the onset of agricultural practice. This remains one of the more serious problems regarding the establishment for the early Neolithic of western Slovenia and the *Caput Adriae*. Cave and open air sites are used

very differently, and the lack of any sites along the flysch soil of coastal Slovenia is problematic. It leaves a gap in the archaeological record, which can be seen both in terms of site type, as well as of geographic distribution. The problem is based on the composition of the matrix and erosion. One example, however, of Neolithic site preservation in the flysch belt is Sermin, which is located on the slope of a low hill.

Regional site distribution from the Mesolithic through the Eneolithic indicates a lack of open air sites in the *Caput Adriae* (fig. 3.24). This is a concern since there is evidence for the use of coastal resources during the Mesolithic and Neolithic, illustrated by the exploitation of marine species (Biagi *et al.* 1993; Miracle 1997; Turk *et al.* 2004; Mlekuž 2005). Nevertheless, without more research and investigation within this coastal region, it cannot be confidently stated that early farming communities (a) did not exist in the region or (b) that the only remains of these supposed early Neolithic communities have not been preserved and are unavailable to the archaeological record. Further investigations of the coastal region, particularly the submerged environment, are required.

## Chapter 4

### Underwater Archaeology of the Northeastern Adriatic

## **Introduction**

Previous underwater archaeological discoveries in western Slovenia can be divided into two distinct categories. The first is a series of inland river sites, primarily located close to the Ljubljana Moor. The second is composed of the underwater sites of the Slovenian Adriatic Sea. While the river sites, particularly of the Ljubljana, cover a broad temporal spectrum, the latter coastal sites are primarily Classical or historical in age. From a methodological perspective regarding Slovene prehistory and underwater archaeology, the river sites are important, because they are the foundation for the practice of underwater methodology in Slovenia. The Roman and historical sites of the northeast Adriatic will be discussed to illustrate the types of finds which constitute the submerged archaeological record from the coastal zone. This is of particular importance due to the nature of archaeological survey and the broad spectrum of archaeological material, which must be considered. Additionally, Stone Age sites from Croatian Adriatic are addressed to further highlight the regional record of underwater archaeological discovery and to establish a foundation for future fieldwork in the eastern Adriatic.

### **4.1 The Slovenian Coast, The Gulf of Trieste and the Northeastern Adriatic**

The Slovenian Adriatic Sea has been a source of underwater archaeological discoveries since the mid 20<sup>th</sup> century, with a particular emphasis on Classical material (Bonton-Tome 1989; Knific 1993; Gaspari 2005). Archaeological materials from the Bay of Piran, near the town of Portorož, have been recorded at the Roman complex Fazine for over four decades (Bonton-Tome 1989; Gaspari 2005). The entire submerged site at Fazine measures 100m by 60m, and is primarily defined by the large sandstone blocks, which make up two large adjoining rectangular constructions (fig. 4.2). The structure itself is made up of these sandstone walls and is 67m long and between 30 and 35m wide (Gaspari 2005), although it was previously documented at 65 by 40m (Bonton-Tome 1989).





Figure 4.1 A diver recovers Roman artifacts from Fazine during the 1963-1964 excavations conducted by the Maritime Museum Sergej Mašera (photo © Muzej Sergej Mašera, as published in Gaspari 2005).

Fazine is situated in shallow water at a maximum depth of just over 4m. Rescue excavations were conducted on the nearby dry land section of the site in 1998 by the *Institute for the Protection of Cultural Heritage of Slovenia*. The results indicate that the classical settlement existed continually from at least the 1st century BC until the 5th century AD (Gaspari 2005). The site is relatively well preserved considering the modern disturbance in the surrounding shallows of the Bay of Piran. Nonetheless finds from the earliest excavations at Fazine lack sufficient documentation for the interpretation of many of the artifacts recovered (Gaspari 2005). Large ceramic amphorae are found in fragments and generally identified through typological classification (Bonton-Tome 1989, fig. 1-3).

The submerged feature at Fazine was measured by hand using traditional methods (Gaspari 2005, fig.4); and by total station laser EDM (fig. 1.4) used to define individual blocks of the feature spatially during the most recent excavations in 2004-

2005.<sup>57</sup> This was made possible by attaching the prism of the rod to an elongated pole held in place by a diver, while the operator measured points from a fixed position on shore. Additionally, the site and its immediate surrounding area were the subject of remote sonar measurements. The result is a 3D rendering of the submerged feature within the overall digital elevation model (Gaspari 2005, fig. 5). The feature, historically described as a Roman pier, harbor or small port (Bonton-Tome 1989, Knific 1993), has also been suggested to be a *vivarium*, or ancient fish farm (Gaspari, pers. com.).



Figure 4.2 The Roman feature Fazine, near Portorož in the Bay of Piran (photo by author).

In 1984, an underwater survey was conducted with the intentions of documenting finds along the Slovene coast, particularly near Piran (Knific 1993). This was completed in partnership with the Piran Maritime Museum Sergej Mašera. It was based on the recovery of ceramic material from around Piran, and particularly on finds from a previously known Roman shipwreck near the town's harbor, originally

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<sup>57</sup> The author was a member of the excavation team during March 2005.

excavated in 1955 (Bonton-Tome 1989, Knific 1993).<sup>58</sup> A focus on Roman finds is logical, given that much of the cultural material from the Slovenian Adriatic is Classical in age. This is illustrated further by the large display of classical material found at the Museum Sergej Mašera in Piran. Other ceramic material, such as three 19<sup>th</sup> century fisherman's pipes were also recovered during the 1984 survey (Knific 1993).

Further east, near the modern town of Izola, another large submerged Roman structure is present in the shallow waters. In 1985, photographs taken at low tide exposed a geometric feature emerging from the water at *Simonov zaliv* (Simon's Bay) to the east of Izola. The feature is exposed only during a very low tide, and is generally submerged between 1 and 0.5m of water (Bonton-Tome 1989, Fig. 1, 2). The adjacent villa to the harbor at Simon's bay was excavated from 1986 – 1992 and Roman fresco fragments, a partially preserved mosaic, and weights from the 1<sup>st</sup> century AD were discovered there (Stokin 2001). A separate structure known as *Viližan* is located to the West of Izola. This feature is composed of walls extending from land into the sea similar to the construction at Simonov Zaliv. Similar to the walls at Fazine, these two features are composed of large sandstone blocks and are interpreted as harbors or small ports (Knific 1993).

In his summary of marine archaeology of the Slovenian coast, Knific (1993) describes nine sites of archaeological value. Two of the sites listed are 20<sup>th</sup> century military shipwrecks: a landing vessel, a barge (fig. 5.19), and a wrecked military airplane is also known to exist in the Bay of Piran (Celestina, pers. com.).<sup>59</sup> The remaining archaeological sites are Roman, including the sites at Fazine, Piran, Izola and Jernej's Bay. Knific cites the first work in Piran in 1955, and on Fazine in 1963, and notes that studies of Roman ports have been topics of archaeological interest in the region with published material as early as 1957.<sup>60</sup> Additionally, the ancient shipwrecks of the Adriatic, especially Roman vessels, are documented by Jurišić

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<sup>58</sup> Underwater excavation technique from 1955 must be addressed critically in respect to modern standards; there is no documentation of excavation practice at this shipwreck.

<sup>59</sup> Master Sergeant Ladislav Celestina, Slovenian Navy, Diving Division & Naval Diving Instructor

<sup>60</sup> Degrassi (1957) as referenced in Knific (1993) and Kovačić (2002).

(2000), through the quantity and typology of amphorae within the archaeological record.

Underwater archaeological discoveries from western Istria, in Croatian territorial waters, have also been recently published (Kovačić 2002). In partnership with colleagues in Ljubljana, Kovačić has produced a report on finds from the western coast of Istria since 1980, presenting a catalogue of finds, mainly from five sites between the towns of Poreč and Rovinj. Photographs and typologies of maritime finds suggest the finds to have been lost goods from maritime transport. This includes much ceramic material ranging from as early as the 3<sup>rd</sup> and 4<sup>th</sup> century BC, based on typological assessments (Kovačić 2002, finds catalogue). Additionally, 2<sup>nd</sup> century AD Roman amphorae and 3<sup>rd</sup> century lamps have been recovered along with much later 19<sup>th</sup> century fishing equipment. Ceramic pipes similar to those examples found near Piran are also documented therein. A single trapezoidal stone anchor has been recovered and estimated, based on typology, to a period between 2<sup>nd</sup> century BC the 4<sup>th</sup> century AD. The concentration of Roman finds is thus associated with the 2<sup>nd</sup> and 3<sup>rd</sup> centuries AD (Kovačić 2002).



Figure 4.3 Map of Roman cities in Istria and surrounding coastal territory (after Glušević in Sténuit et al. 2001).



In 1999, underwater excavations south of Istria, near the island of Vele Orjule, were conducted by underwater archaeologists from Zadar, Croatia. The resulting excavation, at a depth of 43m, produced a life-sized bronze statue of the *apoxyomenos* (Greek type) (Sténuit *et al.* 2001). The recovery, conservation and restoration of the 194cm statue was financed by the Oxford Maritime Trust. Additionally, a lead anchor was recovered 10m south of the statue. Also, 200m west of the statue, at 36m of depth, incomplete amphorae dating from the 2<sup>nd</sup> and 1<sup>st</sup> century BC were found, as well as an African type vessel. However, both of these amphora are believed to be unrelated to the statue. No shipwrecks were found within the immediate vicinity, though it is speculated that the strong Bora winds could have been responsible for a shipwreck in the Orjule channel (Sténuit *et al.* 2001).

Classical and historical maritime finds determine the underwater archaeological record of the Northern Adriatic, to this the Italian territorial waters are no exception. Underwater archaeology is actively practiced in Italy: numerous nautical and maritime archaeology, courses, publications, and fieldworks are conducted. Publications regarding Italian underwater archaeological discovery, and excavation are and have been published, focusing primarily on maritime and classical finds.<sup>61</sup> Dissemination in Italy includes maritime museums and even underwater presentation to the public (e.g. Davidde 2002). Additionally, broad-scale methodological guides to underwater archaeology in Italy have been published (e.g. Gianfrotta & Pomey 1981; Volpe 1999), although such contributions focus mainly on maritime material. No known underwater Stone Age sites from the Italian Adriatic have been published (Beltrame, pers. com.). While familiarization with relevant submerged cultural history is important in conducting an underwater survey, a detailed discussion of underwater archaeological material from the Italian territorial waters is far out of the scope of this dissertation, which focuses mainly on the eastern Adriatic.

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<sup>61</sup> Italian periodicals include: *Archeologo Subacqueo* (*Quadrimestrale di archeologia subacquea e navale*), which as the title suggests, focuses on underwater and maritime archaeology. *Archeologia delle Acque* (*semestrale di antropologia, archeologia, etnografia, storia dell'acqua*), a biannual publication devoted to a broadscale variety of cultural topics. Additionally, there exist multiple Italian language website (e.g. [www.archaeogate.org/subacquea](http://www.archaeogate.org/subacquea); [www.archeosub.it](http://www.archeosub.it); [www.infcom.it:16080/subarcheo](http://www.infcom.it:16080/subarcheo)) devoted to the study of maritime and underwater archaeology.



Figure 4.4 (above) Amphora from the eastern Adriatic. Preserved by freshwater soaking, and displayed in the archaeology museum Zadar, Croatia (photo by author).

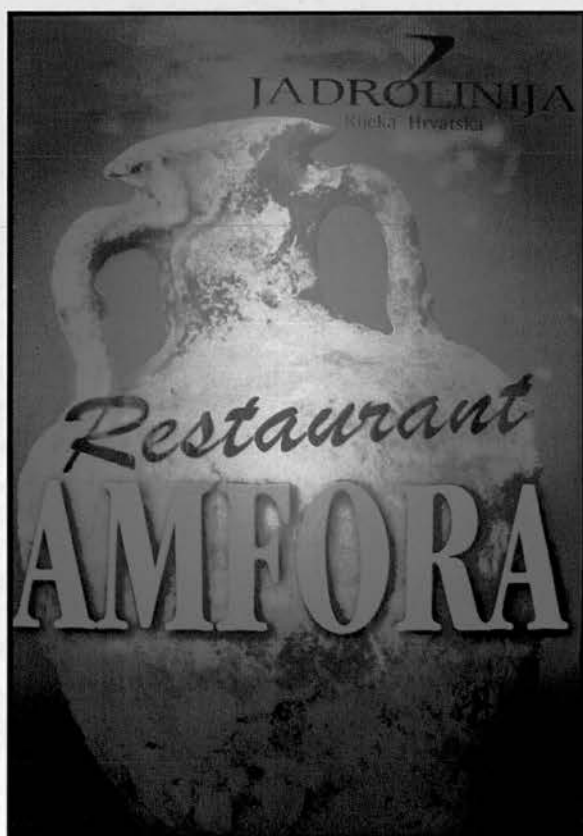


Figure 4.5 (left) Amphora are common cultural material in the eastern Adriatic as shown by this restaurant aboard a Croatian ferry (photo by Author).

Nevertheless, within the Gulf of Trieste itself, there has been archaeological discovery relevant to the region, and a brief mention of this material is applicable herein. In the northwest of the Gulf of Trieste, Italian underwater archaeologists recorded the Roman finds near the lagoon at Grado. Auriemma (2000) has classified the typological chronology of regional Roman finds in *Le anfore del relitto di Grado e il loro contenuto*. Similarly, a shipwreck, measuring 13m long and 6m wide, was found in 15m of water just 6 nautical miles from Grado. The wreck, associated with artifacts typologically dated to the 2<sup>nd</sup> century AD (Beltrame & Gaddo 2005), underwent a series of excavations between 1987 and 1999. The excavated hull was preserved underneath the ship's cargo of Amphorae, which is estimated to have weighed approximately 24 tons. Maritime finds, mainly of wood, have yielded information on the ship's rigging, which is rarely well preserved in known ancient wrecks (Beltrame & Gaddo 2005). There have been no excavations of Roman vessels in the Slovenian Adriatic, although there is at least one example of a known historical shipwreck yet to be excavated (Gaspari, pers. com.).

#### **4.2 Western Slovenia: The Ljubljana River**

The Ljubljana river is 25m to 30m wide, and varies in depth from 3m to 12m; it flows into the Danube via the Sava. The river has been the subject of archaeological survey and discovery for over a century. Finds from the Ljubljana and its banks were recorded by the museum in Ljubljana beginning in 1821 (Gaspari 2003); The Ljubljana has recently been re-examined for its multi-phase underwater archaeological contributions (e.g. Bitenc & Knific 1997; Gaspari 2003), and its first underwater archaeological surveys took place in 1884. This was conducted at the site of Vrhnika with the assistance of the Austro-Hungarian navy (Gaspari 2003) although this involved extraction of finds, and thus can be classified as underwater 'salvage'. In total, by 2003, the Ljubljana had produced its own archaeological record, with over 8,000 artifacts recorded, ranging from the late medieval, to the Neolithic (Bitenc & Knific 1997; Gaspari 2003).

Gaspari (2003) asserts that the geomorphological features of the low-energy river with a deep bed, laying in clay and silt, have produced excellent conditions for both the loss and preservation of material culture, and its eventual recovery by archaeologists. Additionally, Gaspari states that it “presumably has not changed its course markedly from the Copper Age onwards” (p. 46). Copper age materials such as pottery, lithics, horn and animal bone have been recorded in vicinity of the western Moor. Gaspari has thus extrapolated that the finds can be “ascribed to the erosion of the settlement strata or to trading activities related to river exploitation with funerary or votive rituals not to be excluded” (p. 47).

Accidental loss of material has been deemed unlikely, despite the fact that there is no evidence to suggest that finds are associated with any crossings or roadways during the Bronze and Iron ages, or Roman times. Early Bronze age finds are very rare, though later Bronze Age *Urnfield* cultural artifacts are abundant, and include swords, spearheads, axes and sickles, as well as human skeletons. Human remains were associated with a bronze spear recovered in the individual’s chest, and lead Gaspari to speculate that ritual activity was practiced in the vicinity. Additionally, the Ljubljana produced a large quantity of Iron Age *La Tène* finds, mainly weaponry, making it “the largest collection of the eastern Celtic world” (p. 48).



Figure 4.6 A Copper Age logboat from the Ljubljana Moor on display in the Ljubljana National Museum (Photo by Author).<sup>62</sup>

<sup>62</sup> Such logboats are well documented in Neolithic, Eneolithic and Bronze Ages in the region (Erič 1998).



Excavations continue to take place in the Ljubljana, and are conducted mainly by the *Institute for the Protection of Cultural Heritage Slovenia, Underwater Archaeology Group*.<sup>63</sup> In very recent excavations, a human skull was discovered embedded in the riverbank, and was originally presumed to have been a Neolithic aged discovery (Gaspari, pers. com.). However, other prehistoric artifacts were discovered, which appeared pre-Neolithic and were thought to have been associated with this skull (Gaspari & Erič 2006). The oldest site from the Ljubljana and its tributaries is thus discussed below.

### **Zalog pri Verdu**

“Zalog pri Verdu is the first Stone Age site in Slovenia that was discovered and investigated using underwater research methodology” (Gaspari & Kavur 2006, 199). The tributary of the Ljubija stream was the subject of a three day survey of reconnaissance for the construction of a modern bridge. Bronze Age pottery was the initial indication that archaeological material was present and during the twelve days used to conduct rescue survey of the 130m long area, Mesolithic material was discovered. Eventually, over 100 working hours underwater produced a rich assortment of bone, wood, antler, and lithic remains at Zalog pri Verdu (Gaspari & Erič 2006).

Radiometric dating of a female human cranium has placed the age of this site at 7610 – 7960 BC.<sup>64</sup> Two further dates from an Oak trunk and a wooden pile seem to validate this age of Mesolithic occupation ranging between 7000 – 8000 BC. Bone points and Antler axes, with perforation are indicators, which typologically identify this site as Mesolithic (Gaspari & Erič 2006). The stone tools, made mainly from chert, are not associated with hunting, but rather with a more generalized activity. In total this site yielded 302 stone tools, representing 13.4% of all the recovered lithic pieces at the site (Kavur 2006); additionally, 102 stone cores were recovered. All

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<sup>63</sup> This group is lead by Dr. Andrej Gaspari.

<sup>64</sup> Cranium: KIA25792 - 8745 +/- 45 bp.; Oak trunk: KIA24768 8415 +/- 30 bp; Wooden Pile: OxA-15732 7964 +/- 39 bp.

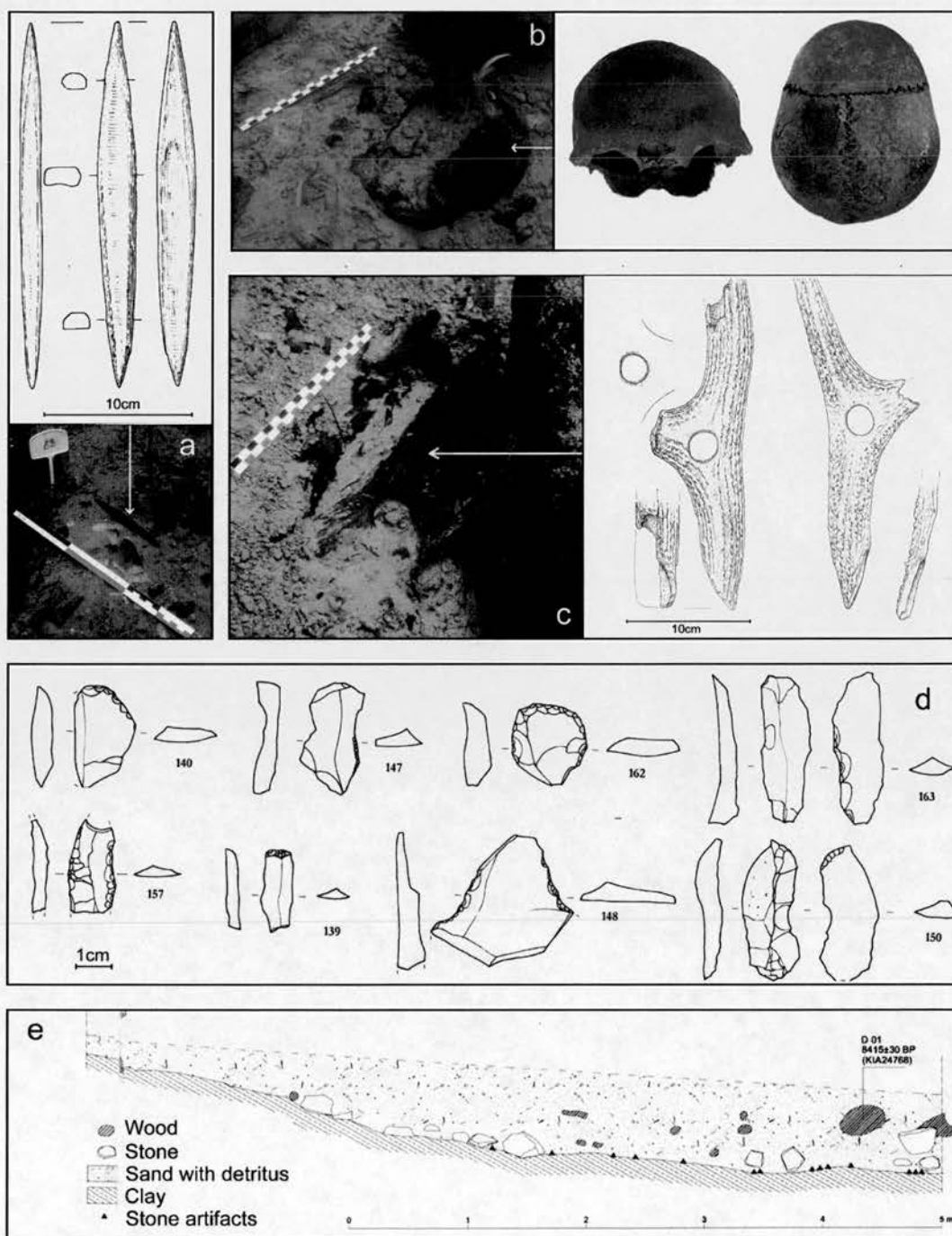


Figure 4.7 Selected material from Zallog pri Verdu; the first submerged Mesolithic site found and excavated in Slovenia using underwater methodology: a) Bone point. b) Human cranium, female. c) Antler axe. d) Lithic artifacts (8 samples of over 300 stone tools present). e) finds locations positioned under sediments (after Gaspari 2006).

lithic material has been catalogued and drawn (Kavur 2006, 73-120). Faunal remains at Zalog pri Verdu show evidence of red deer and wild boar, making up 90% of the large animal remains, although evidence of several species of mammal and bird are present (Toškan & Dirjec 2006).

The material was recovered by both visual survey and hand-collection, and importantly, by the use of a dredge with a 1mm screen. This ensured the recovery of the small material, especially lithic flakes and bone fragments. The artifacts were spatially identified by find location and a distribution map was created (Toškan & Dirjec 2006, fig. 1.10). There is a notable absence of primary contexts, including a lack of hearths, or other identifiable features (Gaspari & Kavur 2006). This shortcoming may have been caused by the movement of the river itself, which could have also disturbed the site by introducing non-cultural material such as faunal remains. The faunal analysis does not include animals that were caught in spring, which has led to the conclusion that this site was seasonal, probably inhabited in autumn (Gaspari & Kavur 2006).

#### **4.3 Prehistoric Underwater Archaeology of the Eastern Adriatic**

While no prehistoric underwater evidence of human occupation has been discovered in the Slovenian territorial sea, evidence further south, in central Dalmatia, suggests a future potential for underwater archaeological discovery of Stone Age sites in the eastern Adriatic. Underwater archaeological practice in Dalmatia has produced modest prehistoric finds resulting only from very limited concerted surveys. Additionally, opportunistic Stone Age finds have been discovered and recorded from the eastern Adriatic, indicating a potential for future study.

Brusić (1977) has presented a series of prehistoric submarine finds from the territory of southern *Liburnia*, otherwise known as central Dalmatia. These are the first prehistoric artifacts from underwater surveys in the eastern Adriatic conducted between the modern towns of Zadar and Šibenik (fig. 4.8). Small islets near the coast, originally connected to land by small bridges or causeways, produced

prehistoric structures and artifacts, including ceramics and culturally worked lithics. In shallow waters, only 3m deep, prehistoric and Roman pottery is documented, as are stone tools artifacts, undeniably several millennia in age despite lacking contextual information and absolute dates (Brusić 1977, fig. 15, 16). Since no further investigations are documented regarding the lithic material or of any submerged prehistoric finds, it is difficult to extract much information from these sites. Chronological and typological data is not discussed in great detail, and only limited descriptions were published regarding the association of artifacts and their locations, though Malez (1979) has suggested that the finds from Stipanac are upper Paleolithic, of Mousterian type (fig. 4.9). These chipped stone artifacts illustrate the potential of Stone Age underwater discovery and can be considered initial indicators for future investigations in the region.

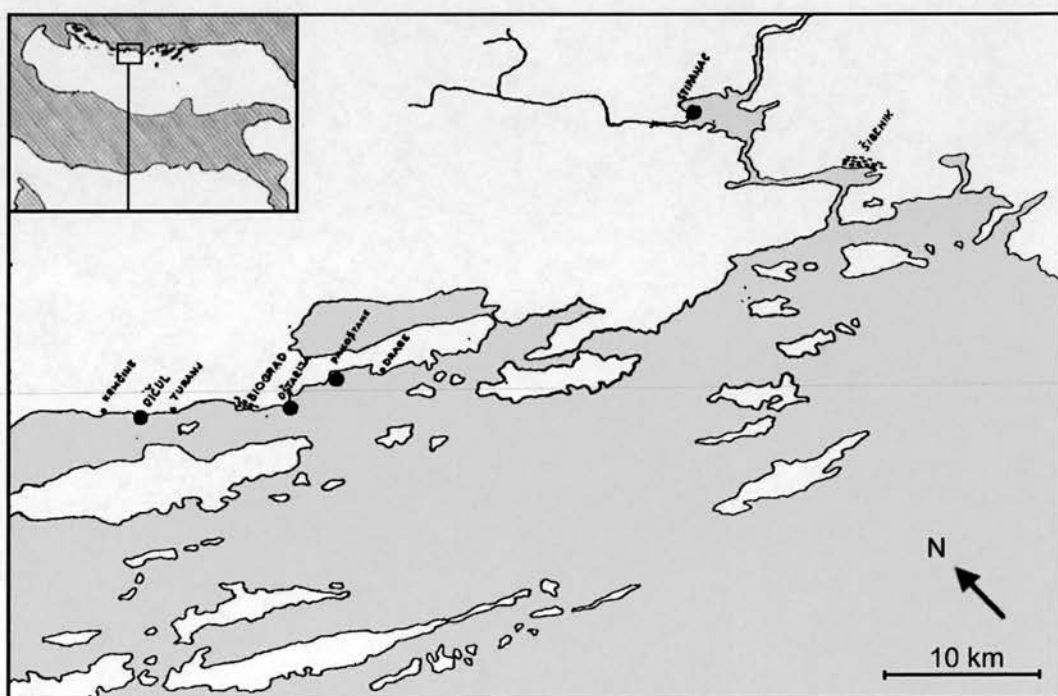


Figure 4.8 Site locations at which prehistoric material was discovered underwater in the 1970's (after Brusić 1977).



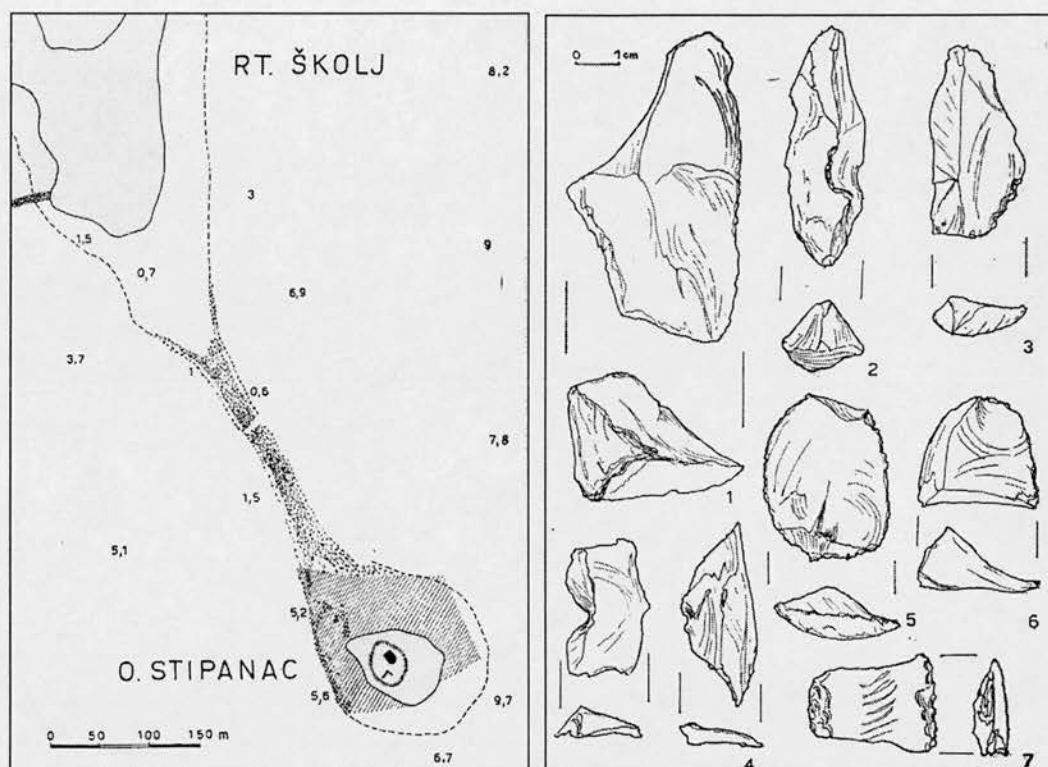


Figure 4.9 (Left) The Islet feature with a shallow submerged dam, or path, previously connected it to shore. (Right) Lithic artifacts recovered from Stipanac near Šibenik (after Brusić 1977).

Similarly, prehistoric lithic finds come from the Dalmatian coastal town at Baška Voda. The finds, now housed in the local museum, are unpublished, and were opportunistically discovered by a diver with ties to the local museum. The lithics, of undetermined age, were discovered in the harbor of Baška Voda when a ship ran aground. In an attempt to dislodge the vessel from the bottom, the boat operator ran the propeller at high speed, which caused a trench-like clearance in the shallow bottom. In doing so, at least five prehistoric lithics were effectively excavated, and recovered by a diver, who turned them over to the museum (Zubčić, pers. com.).<sup>65</sup> The result is a series of finds, which have been salvaged and presented to the public, though no associated information has been obtained. Aerial and satellite views of the harbor at Baška Voda provide a detail of the submerged coastline, and surely diagram a potential for future underwater survey.

<sup>65</sup> Krunoslav Zubčić of the *Hrvatski Restauratorski Zavod* (Department of Archaeological Heritage, Underwater Archaeology, Zagreb, Croatia).

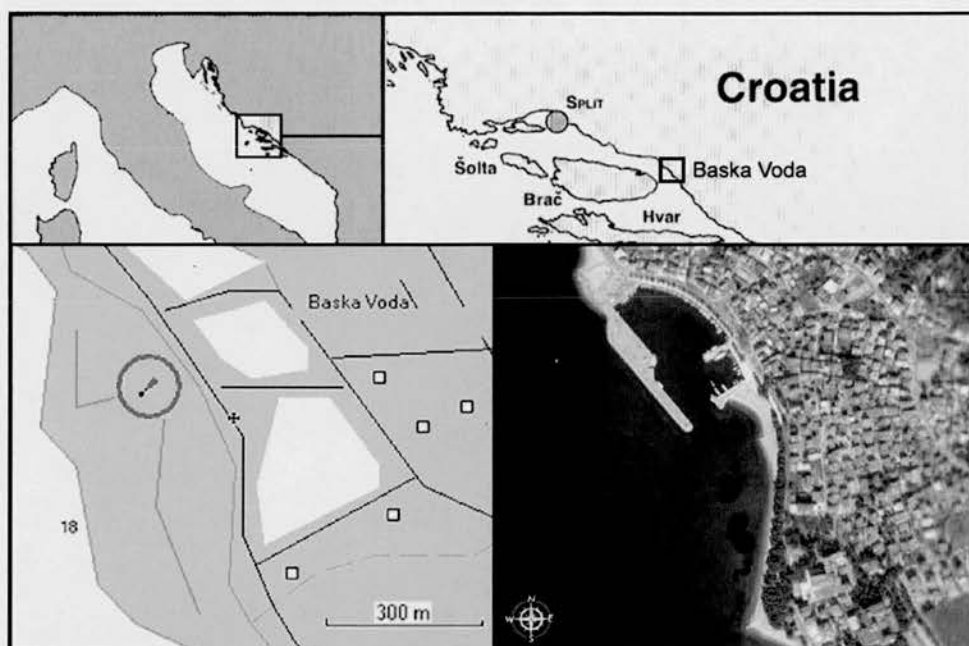


Figure 4.10 Bathymetric chart and satellite image of the harbor at Baška Voda (contrast adjusted). The Paleocoastline, at approximately 10m depth is clearly visible. The chart on the left indicates a drop of to about 18m depth.

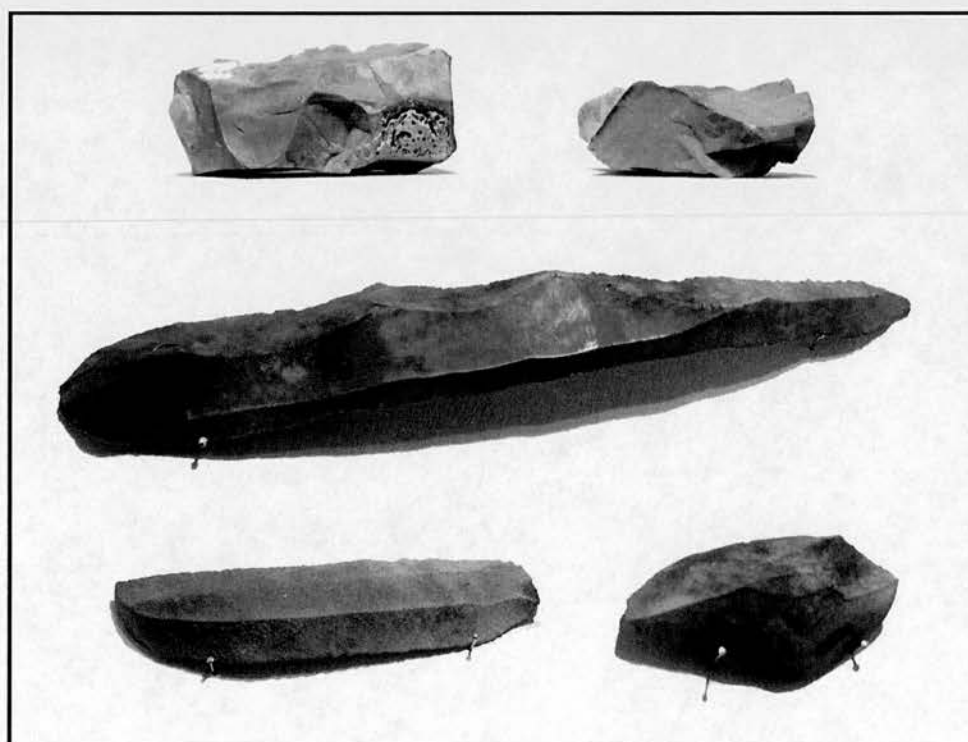


Figure 4.11 Flint artifacts from the harbor at Baška Voda, Dalmatia (Images courtesy of K. Zubčić). No scale given.

#### **4.4 Conclusion: Underwater Archaeology of Slovenia and Surrounding Region**

The submerged prehistoric archaeology of the northeast Adriatic, is limited, although the region is not void of such material. Selected finds from Croatia can be seen as initial starting point for underwater archaeological discovery of Stone Age material in the eastern Adriatic. This evidence is useful despite the lack of additional information or follow-up excavations at and around these locations. This is partly due to the research interest, which dominates the underwater archaeological focus: Classical and maritime finds, often larger, more familiar and more commonly available, are the research priorities in the region. Despite this, methodology for underwater archaeology and submerged Mesolithic activity, principally from the Ljubljana river in western Slovenia is practiced. This can be seen as an indication of a shift in priorities, both in traditional archaeology, which is now more open to investigating submerged environments, and within the underwater archaeological community which is realizing the importance of submerged Stone Age material and the specialization required in seeking out such ancient material. Despite this shift, no recorded underwater archaeological survey has mentioned a specific intent of seeking out Stone Age material from the Gulf of Trieste: the northeastern-most region of the Adriatic Sea. This was the principle goal of the 2005 survey, discussed in the following chapter. Additionally, a further investigation of future studies in the eastern Adriatic is found in Chapter 6 of this dissertation.

## **Chapter 5**

**Original Fieldwork:**

**An Underwater Archaeological Survey of the Slovenian Adriatic Sea**



## 5.1 Original Fieldwork: Project Planning and Considerations

Theoretical planning for the feasibility study designed to assess the potential for underwater archaeology in the northeastern Adriatic Sea began early in 2004. Classified as a non-disturbance survey, the project was based on practical models from underwater archaeological techniques employed in southern Scandinavia over the past three decades (Fischer 1993, 1995), as well as underwater archaeological methods established over the past half century (Bass 1966; St. John Wilkes 1971; Muckelroy 1978; Dean *et al.* 1992). At an average depth of 10m to 20m, dives were conducted to address, not only archaeological questions but also geological, topographical/bathymetric, biological, and sedimentological aspects of the Slovenian Adriatic. Defining these physical aspects and logistical variables helped predict locations of potential archaeological interest. The survey team documented its process, and findings in line with standard archaeological practice.<sup>66</sup> Methodology and results are discussed herein.

### Project goals: A multi-functional study

- 1 Conduct a survey for evidence of submerged prehistoric human activity based on the model established for southern Scandinavia.<sup>67</sup>
- 2 Make adaptations to the southern Scandinavian model to suit an Adriatic context both geographically and archaeologically.
- 3 Confirm bathymetric charts and create more detailed presupposition points for survey.
- 4 Encourage underwater archaeology as a standard for the survey of submerged cultural landscapes within the scientific and sport diving communities.<sup>68</sup>
- 5 Record and report all material culture, regardless of age or type, in line with standard archaeological practice.

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<sup>66</sup> Additionally, UK Health & Safety standards were followed.

<sup>67</sup> The Danish Model for the presupposition of submerged sites as described in the previous chapter.

<sup>68</sup> This includes raising the awareness within the sport diving community, and help to identify what to look for and what to do / who to contact when archaeological material is discovered underwater.

### 5.1.1 Sea Level Rise in the Northeastern Adriatic: Depth to Age Ratio

Presupposition or predictive modeling of submerged prehistoric archaeological sites requires a well established reconstruction of the landscape in question. Such an understanding of land and sea in prehistory requires a multi-disciplinary approach. Prior to the discussion of presupposing submerged sites, landscapes and paleocoastlines of the northern Adriatic Sea, and the Gulf of Trieste must be examined and reconstructed. The theoretical planning of this survey involved researching data from geological, marine biological, and archaeological sources and the accuracy of paleolandscape reconstructions depends on the quantity and quality of data available. Hence, existing reconstructions require critical analysis, as important variables may not have been considered, thus rendering such a reconstruction obsolete. This is especially true, given the necessity of local considerations (Pirazzoli 1996).

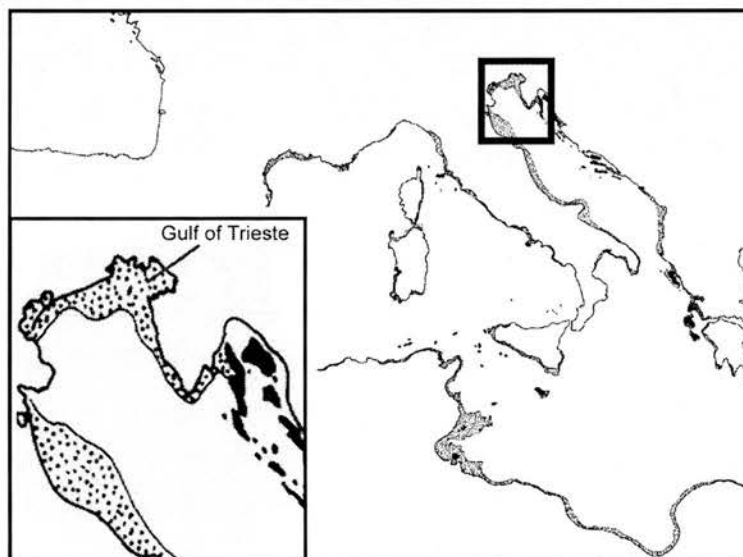


Figure 5.1  
A general reconstruction  
of the western  
Mediterranean at c.9000  
BP (after Shackleton *et al.* 1984).<sup>69</sup>

Based on the environmental data from core samples as well as two additional inland sites at Conselice, and the Roman site Aquileia, a sea level rise curve for the northern Adriatic was recently generated (Lambeck *et al.* 2004). Using this statistical curve as a base upon which to reconstruct paleocoastlines of the northern Adriatic

<sup>69</sup> Issues with sea level rise and recent reconstructions used to indicate paleocoastlines of the Gulf of Trieste are addressed at the end of this chapter.

Sea, approximate age to a depth contours may be inferred (fig 5.2). Given the statistical margin of error, the windows were assigned and median dates derived from these windows. This data is consistent with the global sea level curve as established by Fairbanks (1989) and van Andel (1990).

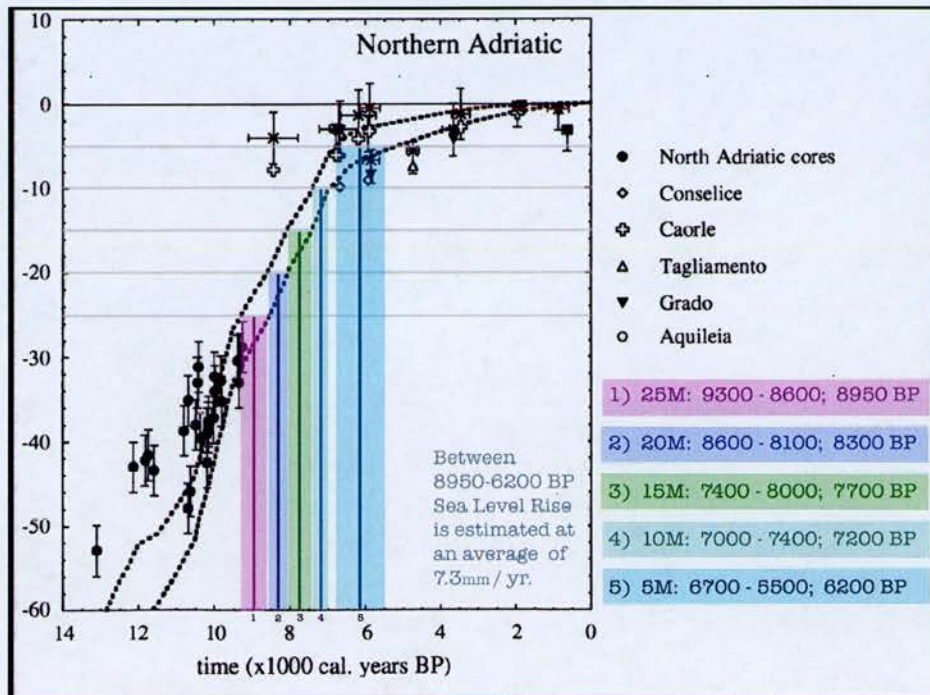


Figure 5.2 Final Pleistocene and Holocene Sea level rise of the northern Adriatic Sea (adapted from Lambeck *et al.* 2004). At 25m depth below sea level,  $\mu = 8950$  BP (within a margin between of 9300 – 8600 BP). At 20m  $\mu = 8300$  BP, (8600 – 8100 BP). At 15m  $\mu = 7700$  BP (8000 - 7400 BP). At 10m  $\mu = 7200$  BP (7400 – 7000 BP). At 5m depth  $\mu = 6200$  BP (6700 – 5500 BP). These curves were used to estimate a depth: age ratio. Due to the notable lack of data between the 30m and 5m depths, the suggested ages should be considered approximate.

From this initial reconstruction of early Holocene coastlines of the northern Adriatic Sea, it is possible to establish areas of potential prehistoric occupation. In the case of this fieldwork, it is most likely that Mesolithic-Neolithic coastal sites would be found just above the corresponding shoreline which was estimated between 10-20m depth, according to this graph,. However, this depth range does not include additional considerations such as geological and sedimentological variables, human disturbance, and accessibility. The purpose of such data is to establish *approximate* dates for bathymetric contours found on the available nautical charts. This serves as



the initial reconstruction of the paleocoastline, and has been utilized by previous researchers (van Andel 1983, 1989; Budja, 1997; Forenbaher 2002) to give a general idea of coastlines during the Mesolithic and Neolithic. This practice serves as a beginning point for field archaeologists to establish potential survey locations, though adjustments and reconsiderations are to be expected based on local variables.

### **5.1.2 Regional Familiarization & Project Planning**

Due to the nature of planning an international project, it was not possible to thoroughly address *all* of the regional issues and available resources in the northeast Adriatic from abroad. A series of trips were conducted to the Gulf of Trieste, as well as to southern Scandinavia for theoretical discussions; this was a critical part of the planning phase of this study. Other physical and logistical variables are described herein for their impact on archaeological potential.

#### **Initial trips to Italy, Slovenia and Denmark, 2004**

In order to assess the physical and archaeological components of the northeastern Adriatic, the author visited the region twice prior to the summer of 2005. An initial trip to the University of Venice, and the city of Trieste in March of 2004 included a visit of the grotta d'ella Edera. Discussions with Italian prehistorians and an underwater archeologist<sup>70</sup> at this time, suggested that while much prehistoric material may be submerged off the coast of northeastern Italy, the conditions are problematic because the lagoons provide a challenge due to sedimentation (fig. 5.3; Beltrame, pers. com.).

A second visit to the region during the summer of 2004 was carried out in conjunction with fieldwork at Mala Triglavca (Chapter 3, fig. 3.9). During this trip, spent predominantly on site and in the nearby town Divaca, a single reconnaissance SCUBA dive in the Slovenian Adriatic was conducted to assess visibility,

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<sup>70</sup> Dr. Paulo Biagi, and Dr. Carlo Beltrame (University of Venice) and Dr. Giovanni Boschian (University of Pisa).



temperature, and familiarization with the local diving community while on location. Also during this trip to Slovenia in 2004, meetings were arranged with members of the local academic community from the two universities at Ljubljana, and Koper.<sup>71</sup>

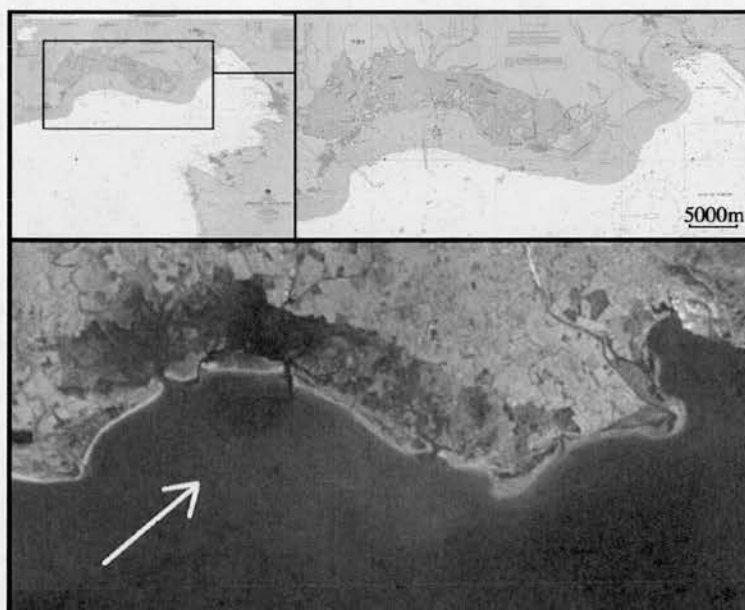


Figure 5.3 The Italian lagoons of Grado and Carole deposit sediments into the northern shallows of the Gulf of Trieste (above) Bathymetric charts 1:75,000 (below) Satellite image (© NASA) show the visible plumes of sediments deposited into the Gulf.

In August of 2004 the author traveled to Copenhagen to discuss the southern Scandinavian method for underwater archaeological survey.<sup>72</sup> In addition to questions of logistics, staff, and equipment, preliminary survey locations were discussed based on a nautical chart of the Gulf of Trieste (1:75,000 scale).<sup>73</sup> At this time, confirmation of scale and appropriateness of the available chart were discussed with the conclusion that the chart would be adequate. The theoretical presupposition points identified at this time were based on topographic features, charted bathymetry, and depths. Localized variables such as currents and sediments were thoroughly investigated at a later time.

<sup>71</sup> Dr. Michael Budja, Ljubljana University, Dr. Andrej Gasparij, Primorska University, Koper.

<sup>72</sup> The author met with Dr. Anders Fischer of the Kalundborg Regional Museum.

<sup>73</sup> Chart 54169 National Imagery and Mapping Agency (© United States Government, 1999).



Figure 5.4 Bathymetric chart 54169 (Gulf of Trieste) was used during the initial plotting phase in Denmark (Original scale 1:75,000, 1999).

### Physical properties of the Slovenian Adriatic coast & region-specific issues

The physical environment and those variables which affect underwater archaeological survey were the principal pre-fieldwork considerations. At times, conducting underwater archaeology can be impossible given compromised conditions, such as poor visibility and unsuitable seabed composition, and it is important to recognize the elements which can compromise underwater fieldwork.<sup>74</sup> The Gulf of Trieste is isolated from the rest of the Adriatic Sea by a shoal between Grado, Italy, and the northwestern most point of Istria, Sauvudria, Croatia (Ogorelec *et al.* 1991). In between the point of Sauvudria, and Punta Grossa (the modern Italian border), is 46km of coast belonging to Slovenia. The gulf itself is a relatively shallow basin at an average of 20m – 25m depth (Ogorelec *et al.* 1991).

### River systems

River systems on the coast of Slovenia and northeast Italy contribute to the underwater environment, as large quantities of sediments are continuously deposited in the gulf (Ogorelec *et al.* 1991; Vahtar, 2003). The rivers found in coastal Slovenia are the Rižana and Badasevica, which terminate in Koper, and the Dragonja, which terminates at the salt flats of the Bay of Piran and serves the

<sup>74</sup> Familiarization with the physical environment of any the region will reduce such difficulties.



political border dividing Croatia from Slovenia. The Soca river, known as the Isonzo in northeast Italy, has a lesser effect on the sediments of the Slovenian territorial sea, though it influences the northern part of the Gulf of Trieste, particularly during the early summer. This river mouth on the Italian side of the Gulf peaks during the spring melt-off of the northern Italian and Slovenian Alps, causing the maximum impact in the gulf during July (Ogorelec *et al.* 1991).



Figure 5.5 The river systems of coastal Slovenia (after Vahtar 2003).

## Geology

The geology of coastal Slovenia is composed of Eocene Flysch except for a small limestone base at Izola (Pavšič & Peckmann 1996, fig. 1). Since flysch is a combination of layers of clay marls and sandstone, as well as intermittent limestone and calcarenites, erosion patterns differ greatly from those just a few kilometers to the southwest in Croatian Istria, which consists of limestone. Flysch sediments eroding over the millennia cause sharp cliff faces at the site of previous ridges. Pleistocene valleys have evolved into the predominantly muddy Bays of Koper and Piran. The Natural process of erosion along the flysch cliffs create shingled beaches of sandstone, since the soft clay erodes quickly, leaving exposed ledges of harder rock (fig. 5.6). Eventually, these ledges succumb to gravity and break off in blocks. The result is shingled beaches. Cliffs with higher rock content tend to be more vertical, while clay rich cliffs tend to be gentler in slope as well as lower in height (Vahtar, 2003).



Figure 5.6 The flysch cliffs near Piran. Strata of sandstone and clay marls are visible (photo by author).

### Sediments and seabed composition

While river systems deposit softer materials into the bays and create sedimentological issues for underwater archaeologists, areas void of muddy silt exist only sporadically along the coast. Sandy bottom compositions exist in much greater frequency further from the coast, while sediments in the gulf increase closer to shore (Ogorelec *et al.* 1991, fig 1, 3). Sediments near the middle of the gulf, comprising approximately 30% of the surface area, are composed of silt and sand, of which less than 10% is clay, and carbonate content is between 50-80%. This is compared with the 40% clay, and 5% sand composition of the Koper and Piran Bays (Ogorelec *et al.* 1991, fig. 3) “a gradual increase in grain size towards the open part of the gulf is clearly evident. The sediments of the Koper and Piran bays are mainly composed of silty clay with about 60% clay, while in the central part of the gulf sand prevails, consisting of about 80% of biogenic detritus” (Ogorelec *et al.* 1991, 82).

Sedimentation rates of the inner bays of Koper and Piran are deposited at a rate of 5.3mm per year (Ogorelec *et al.* 1991). A radiocarbon date from the inner salt marsh from the bay of Piran (core V6) yielded a date of 8110 BC (9120±120 BP), and showed the peat sampled at approximately 28m depth (fig. 5.10), indicating accumulation at a rate of 3mm per year; in comparison with the rate from the central Gulf of Trieste, which is measured at just 1mm per year, and increases to 2.5mm per



year nearer to the Isonzo river mouth. Further south, in Croatian waters, the limestone structure of central western Istria, offshore samples from near Poreč exhibit only 0.03mm of sedimentation per year (Ogorelec *et al.* 1991). This figure shows the impact resulting from local soil, erosion, and geological make-up, and the difference between flysch and limestone on Holocene sediments of the seabed.

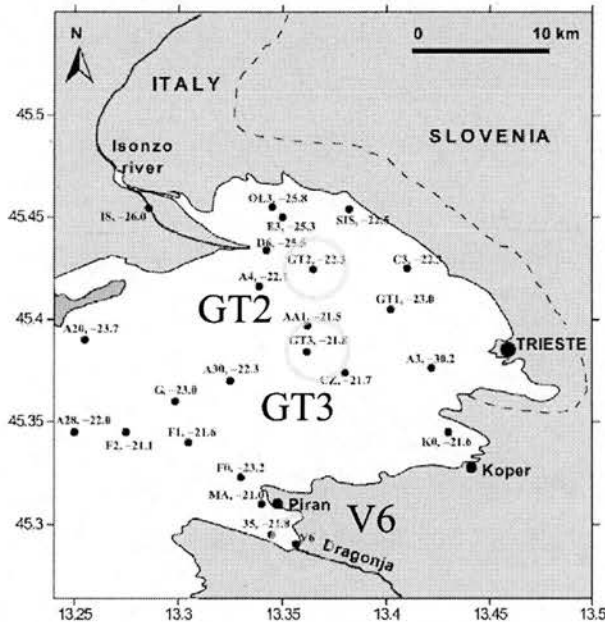


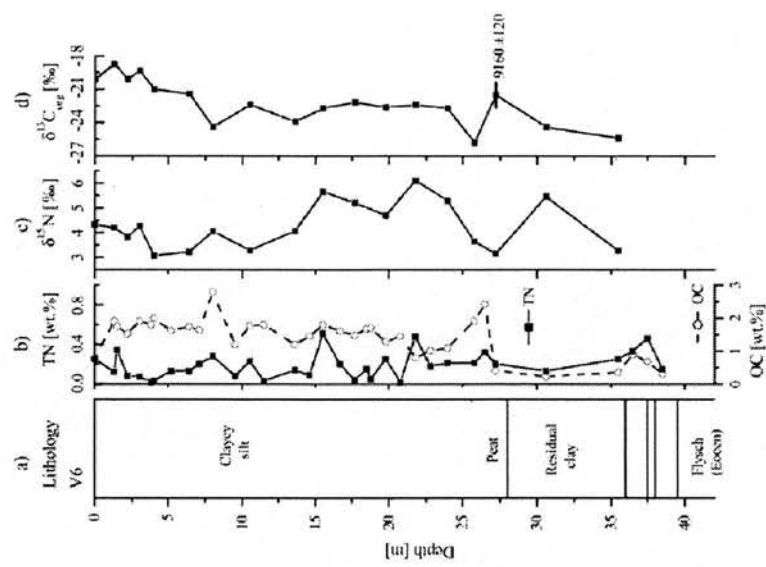
Figure 5.7 Core samples taken throughout the Gulf of Trieste with three referenced samples discussed for radiocarbon determinations of the age of transgression and sedimentation rates. (GT 2) seabed depth of 22.3m GT 3 seabed depth of 21.8m V6 surface core of Piran Bay saltmarsh (after Ogrinc *et al.* 2005).

<sup>13</sup>C and <sup>15</sup>N levels were measured (Ogrinc *et al.* 2005) to analyze Holocene sediments on the surface

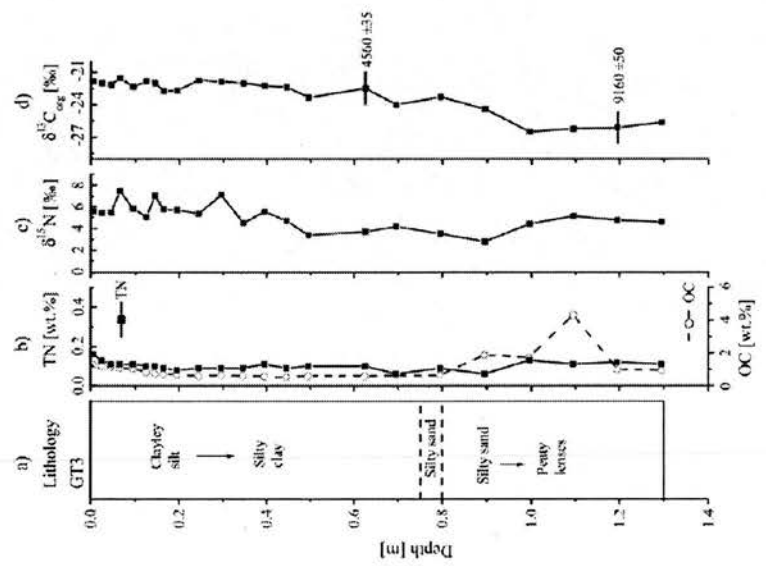
of the seabed of the Gulf of Trieste; core samples were taken with a light gravity core sampler 4cm in diameter. Additionally, core V6, taken from previous sampling (Faganeli *et al.* 1987) was reanalyzed. Results from the sampling show that while early Holocene layers lay underneath tens of meters of sediment near the river mouths of the bays of Koper and Piran (Ogorelec *et al.* 1991), samples from the middle of the gulf taken only 1.5m sub-bottom depth (GT 1) were dated to 8040 BC (9030±70 BP). A second core sample (GT 2) yielded a date of 8230 BC (9160±50) at just under 1.2m sub-bottom depth and 4510 BC (5860±40) at 0.75m. A third sample (GT 3) resulted in radiocarbon determinations indicating ages of 8230 BC (9160±50) at just under 1.2m sub-seabed depth, and a date of 3000 BC (4560±35) at 61cm sub-seabed (Ogrinc 2005).<sup>75</sup>

<sup>75</sup> Problematic aspects exist from the samples taken at V6 where a single piece of wood was dated, and GT2 where younger dates are found out of sequence (fig 5.6). This data may have come from transported material and thus gives dates out of sequence, though the peat lenses can be considered a more reliable material for dating strata.

V6



GT3



GT2

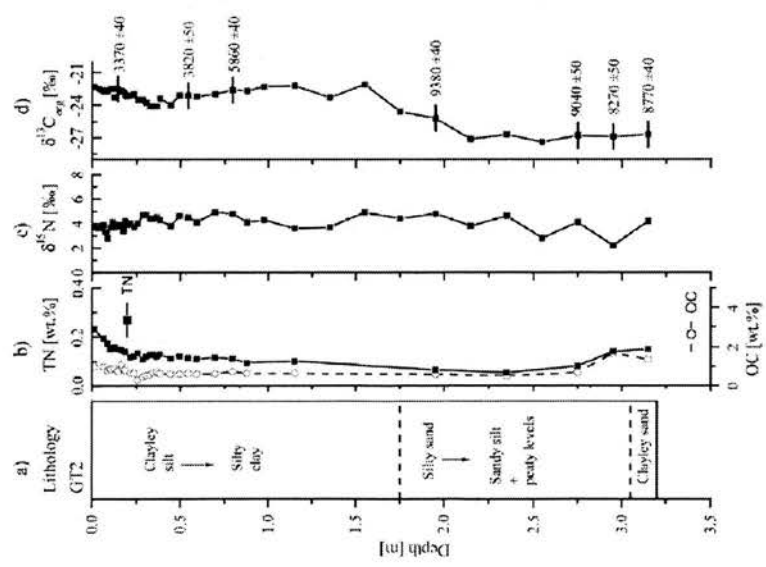


Figure 5.8 (previous page) Vertical Profiles and  $^{14}\text{C}$  determinations from cores including a) lithology b) organic carbon c) total nitrogen d) organic  $^{13}\text{C}$  values. (I) GT2 (II) GT 3 (III) V6 (after Ogrinc *et al.* 2005).

The impact of sediments on potential archaeological survey are highly influential and the Slovenian situation is no exception. Eocene flysch from riverbeds deposit large amounts of sediment into the bays (Ogorelec *et al.* 1997), thus sedimentological factors must be acknowledged for their impact on underwater archaeological potential for the Slovenian Adriatic. While this presents a considerable challenge, it does not imply that there is no potential for archaeological significance. There exist many variables that impact site discovery (Flemming 1983), and sedimentation does not always prohibit the discovery of Stone Age material on the seabed (Fischer 2006). Furthermore Sedimentation can protect prehistoric archaeological sites (Geddes *et al.* 1983; Malm 1995; Momber 2001; Lübke 2001). Therefore, although the Eocene flysch poses a significant challenge, prehistoric underwater discovery and potential for underwater archaeology in the Slovenian Adriatic should not be disregarded based on sediments alone.

Radiocarbon determinations from core samples GT2 and GT3 have yielded early Holocene dates from levels 0.5m to 2.0m sub-seafloor. These samples indicate dates as old as 8230 BC ( $9160 \pm 50$ ), corresponding with the Mesolithic cultural age of the eastern Adriatic (Biagi *et al.* 1993; Miracle *et al.* 2000; Forenbaher & Miracle 2005). According to the core samples from the gulf, it is possible that archaeological material from the late Stone Age may lay *in situ* under less than 1m sub-seabed.<sup>76</sup>

In addition to the work provided by the Institute of Marine Biology in Piran, the university of Trieste department of Geology has conducted boreholes and dated samples from Italian waters (Marocco *et al.* 1991, Gordini *et al.* 2002). Deposits at Trezza Grande are approximately 6m thick and characterized by a continuous sequence of circalittoral sediments at the bottom with infralittoral sediments found above (Gordini *et al.* 2002). Geologists from the University of Trieste also discuss small scale regional tectonic activity, which is confirmed by data showing evidence

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<sup>76</sup> Although questions regarding the sea level rise and transgression data of the Gulf of Trieste must be addressed for this to be considered.

of minimal subsidence in the general region of the north Adriatic (Lambeck *et al.* 2004). Coastal evolution, as determined by post-glacial sea level rise, has been subjected only to very little regional subsidence in comparison with the littoral zone found south of Po river delta (Brambati *et al.* 2003).

### **Salinity, temperature, tides, atmospheric pressure & sea currents**

Salinity levels of the sea within the Gulf of Trieste range from 33‰ to 38.5‰ in the surface layer, and a slightly saltier 36‰ to 38‰ close to the bottom. Temperature varies substantially depending on the season, and surface temperatures can be as cool as 8°C in the winter, reaching 24°C in the summer. Bottom temperatures are cooler, ranging between 8°C and 20°C (Ogorelec *et al.* 1991). Tidal influence of the Slovenian Adriatic is minimal. Tides, and atmospheric pressure along the Slovenian Adriatic generally cause a fluctuation of less than 1m (0.5m range) (Ogorelec *et al.* 1991; Vahtar, 2003), thus while there is some tidal movement, it is not significant relative to the world's oceans and seas. Erosion patterns, topographic features, sea level rise and the way in which transgressions of the Gulf are understood impact the location of potential submerged archaeological sites. Barometric pressure in the



region can vary, which, in addition to strong winds, can affect sea levels of the Gulf of Trieste (Raicich 2003) in extreme circumstances by an additional 1m (Ogorelec *et al.* 1991).

Figure 5.9 The main sea current in the Gulf of Trieste (after Vahtar 2003).<sup>77</sup>

<sup>77</sup> Vahtar cites Briceij (2002).



The prevailing current of the Gulf of Trieste is a counter clockwise motion (fig. 5.9), entering the gulf from the point of Sauvudria, Istria, and exiting at the lagoons of northeastern Italy (Ogorelec *et al.* 1991; Vahtar 2003). During spring months, when fresh water flows into the Gulf from the mountain runoff, density changes enough for currents to be affected by the inflowing Isonzo river. Individual bays along the northern coast of Istria and the Slovenian Adriatic can exhibit swirling currents based on movements within the individual bays,<sup>78</sup> and as a result of winds, especially during the strongest Bora winds which can affect both currents and sea temperature (Krajcar 2003).

### **Human disturbance**

Human disturbance is a common element in the consideration of archaeological fieldwork. Problematic aspects concerning underwater survey include modern constructions, maritime shipping routes, fishing, pollution, and treasure hunting. The obvious examples of human disturbance are the numerous ports and harbors, which range in size and impact throughout the Gulf of Trieste. Individual considerations of disturbance are addressed herein relative to specific survey locations.

#### **5.1.3 Nautical Charts & Presupposition Points**

The two most important variables of a nautical chart, when used to predict underwater archaeological sites, are scale and accuracy. Although, quality and accuracy may not be obvious or measurable during the initial viewing of a map, the scale is self-evident. Ideally, the more detailed, and higher resolution charts, created by the most accurate survey methods, are best for presupposing submerged sites. Nautical chart *catalogue* 54169 (1999) was used to presuppose sites of potential interest for this survey. This chart was created from surveys conducted by Italian and US governments between 1983 and 1998. The scale of this chart of the entire Gulf of Trieste, 1:75,000, was suggested to be functional for such presupposition, and has

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<sup>78</sup> The varying currents were encountered by the survey team during fieldwork.

been used successfully in Scandinavia (Fischer, 1993, 1995). The author's own suggested presupposition points were discussed and recommended alternative locations were plotted on the chart (Fischer, pers. com.).

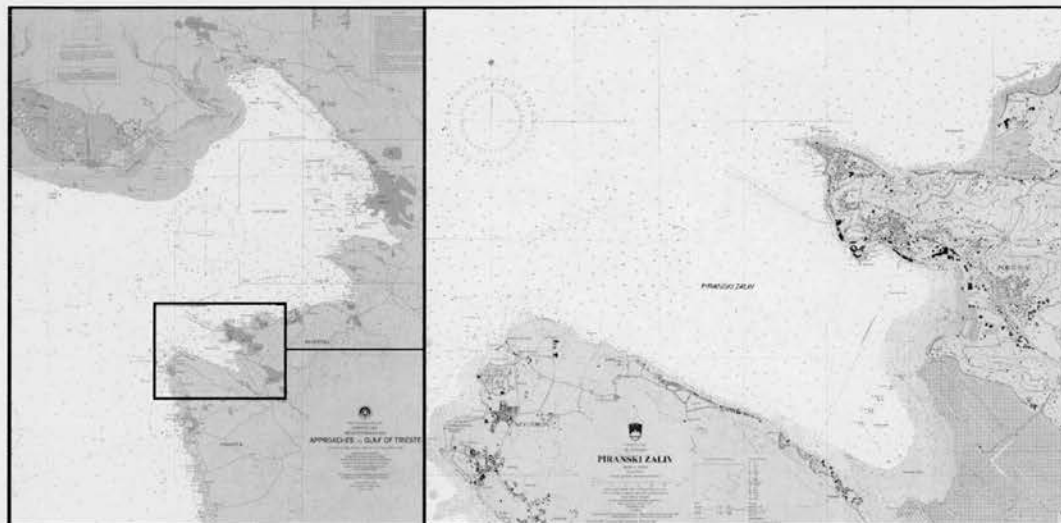


Figure 5.10 Nautical charts used for the planning of the survey. (right) Nautical Chart of the Bay of Piran was used once onsite in Slovenia in 2005. Original Scale 1:12,000 (Courtesy of Harpha Sea, Koper, Slovenia).

A more detailed nautical chart of the Gulf of Trieste, in its entirety, was not available at the time of initial predictive discussions. Once the decision was made to seek out sites in Slovenia specifically, and exclude areas of Italy and Croatia, higher resolution charts for the Slovenian Adriatic were sought and eventually employed.<sup>79</sup> In the months prior to the survey, two nautical charts of the Slovenian Adriatic, Piran and Koper Bays, were created, each at a scale of 1:12,000.<sup>80</sup> These charts were later employed for a detailed bathymetric data, and a reevaluation of the presupposition points within Slovenian waters. The finer scale (1:12,000) charts, created in WGS 84 standard, were predictably useful tools to the survey. A reevaluation of quality and resolution of nautical charts and their impact on survey,

<sup>79</sup> These charts were not obtained until spring of 2005 due to lack of availability.

<sup>80</sup> The chart of Koper Bay was published in late 2004, while the Piran Bay chart was created in early 2005 and remained unpublished even during the time of survey. Since the Piran Bay chart was not commercially available at the time of the survey, a request was made in person to the of submarine profiling company Harpha Sea, based in Koper, and the chart was obtained prior to its public release.



the survey. It was anticipated that this plan would be adjusted and expanded on given regional variables and issues, which would presumably arise in the field. Local knowledge was deemed valuable and local assistance and collaboration were sought.

Prior to isolating the survey to include only Slovenian territorial waters, six areas in Italy, seven in Slovenia, and two in Croatia within or immediately near the Gulf of Trieste were plotted on chart 54169 (fig 5.4). Of these areas hypothesized to be of archaeological potential, five were confirmed as appropriate to the model (Fischer, pers. com.), while four additional locations were added in Croatian waters, thirteen in Italian waters, and three in Slovenian territorial sea. Due to the prevailing obstacles of sedimentation, a modern harbor, modern political borders, recommendations from regional specialists, and legislation, the Italian territory of the Gulf was eliminated from the survey plan. Similarly, Croatian law prohibits diving in Croatian waters, and requirements for archaeological fieldwork are considerably stricter by comparison to other European countries,<sup>82</sup> thus survey in Croatian waters was not impossible during the 2005 season.

#### **5.1.4 Logistics, Financial Constraints, and Legal Considerations**

Underwater archaeological survey takes longer and is often much more expensive to conduct than traditional fieldwork (Dean *et al.* 1992; Malm 1995). In order to conduct an archaeological survey an estimated budget of costs must be established to ensure success within financial limits and the same principles apply to the practices of underwater archaeology (Dean *et al.* 1992). The major difference is that underwater archaeology involves specialized diving equipment and staff, and includes limitations, such as amount of time spent underwater, resulting in a slower process of survey. While logistical requirements can be planned in the theory, it would be impossible to include some of the specific fixed costs for the survey of the Slovenian Adriatic, until on location, prior to the survey during the spring of 2005.

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<sup>82</sup> Croatian legal requirements and restrictions for archaeological fieldwork and underwater archaeology require a team leader of Croatian nationality, a staff of at least 50% Croatian citizenship, a working vessel with Croatian registry, and professional (paid) staff members (even students).



This is mainly due to a lack of funding, requiring equipment and material to be obtained either on loan, or through partial donation. All preparations, which could be made prior to arrival in Slovenia, were managed in the winter of 2004-2005, though specific items were left until April and May out of necessity. During a period of seven weeks, prior to the survey, the logistical requirements defined as part of fieldwork preparation and regional familiarization were sourced and obtained.

### International recruitment & liability

In February of 2005, the Department of Archaeology at Edinburgh University posted a website calling for volunteers for the underwater survey (fig. 5.12).

Undergraduates, graduates, and postgraduate students of all levels, were eligible to apply, regardless of their degree subject. Interested proficient divers, without archaeological experience were considered, though an archaeological background was preferred.<sup>83</sup>

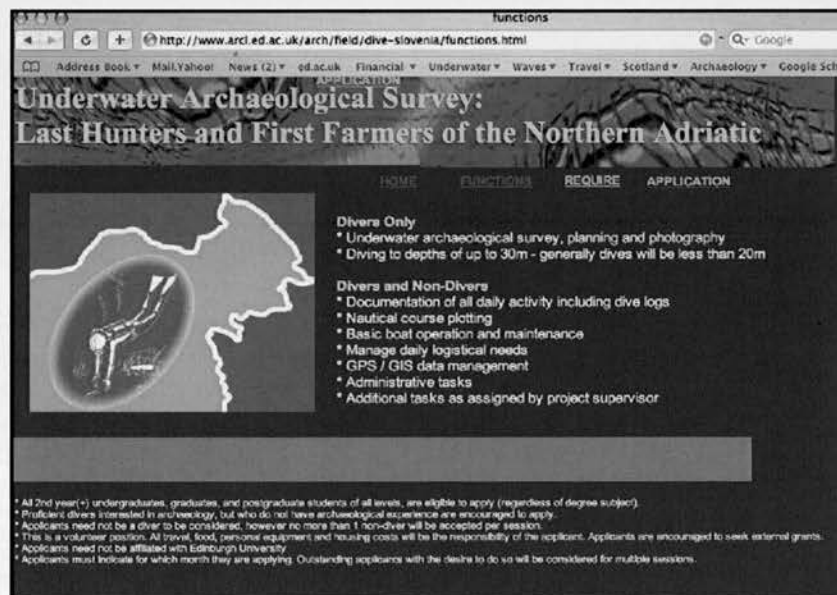


Figure 5.12 The original point of contact for applicants was this University of Edinburgh website.

<sup>83</sup> Due to very limited funding for the project and a total budget of £1500, all travel, food, personal equipment and housing costs were the responsibility of the volunteer, and applicants were encouraged to seek external funding.

The actual underwater survey was divided into two separate month-long sessions during June and July. Since travel, living, and individual equipment costs were covered by the individual volunteers, two sessions of one month were conducted to avoid excessive costs on the volunteers and to keep the team members from tiring. An email was sent to approximately fifty academic institutions around the world, which offer underwater, maritime, or nautical archaeology as a degree course.<sup>84</sup> The preliminary applications were screened and assessed before a CV was requested from the most qualified applicants. The more qualified applicants were considered over the following months until final decisions were made in the early spring of 2005. In addition to the author (the principal surveyor), three surveying divers were accepted for each month of June and July. The team of volunteer divers included postgraduate and undergraduate level archaeology and maritime archaeology students, and one completed Master of Science in maritime archaeology.<sup>85</sup>

Prior to arrival in Slovenia the risks involved with archaeological fieldwork and diving were considered in accordance with British Health and Safety regulations.<sup>86</sup> Volunteers were required to sign a medical statement, and risk assessment, as well as show proof of medical, and diving insurance. Staff were also required to give a self-declaration of diving fitness.



Figure 5.13 The south-facing view from Šentiana of the Bay of Piran. The Croatian territory of Savudria is in the background.

<sup>84</sup> As anticipated, department secretaries forwarded the message to staff and students, who were encouraged to apply online.

<sup>85</sup> One of the surveyors remained on the survey team for both sessions. Diving qualifications included commercial diver (HSE III C-D-T Commercial Diver Training), Dive Instructor (PADI), and Rescue Diver (PADI). Details of the individual survey team members included in the appendix.

<sup>86</sup> *Scientific and Archaeological diving projects*. The Diving at Work Regulations 1997 Approved Code of Practice and Guidance - L107 & *Commercial diving projects inland/inshore*. The Diving at Work Regulations 1997 Approved Code of Practice and Guidance - L104.

## Legal permission and local collaboration

A Slovenian collaborating partner was required for legal permission, and a collaborative agreement with the *Pomorski Muzej Sergej Mašera* (Piran Maritime Museum) was eventually established.<sup>87</sup> Official permission to conduct archaeological survey was applied for to the *Zavod za Varstvo Kulturne Dediscine* (Institute for the Protection of Cultural Heritage) of Slovenia, and granted with the express understanding that all finds of archaeological interest would be reported to the local Institute for the Protection of Cultural Heritage branch office in Piran. Initially, permission to surface finds was not sought, as project goals intended only to establish locations of positive finds, or areas of highest potential for prehistoric sites.<sup>88</sup> Eventually, once the project was nearly completed, an agreement was established, and permission granted for selected cultural material of potential archaeological significance to be surfaced and turned over to *Pomorski Muzej Sergej Mašera* along with an initial report. The permission and agreement were completed by the institute, museum, and author.<sup>89</sup> Finds are discussed in detail in the results section of the following chapter.

Legislation and politics can affect the underwater archaeologist in a variety of ways, as was the case in Slovenia during the Spring and Summer of 2005. In addition to acquiring a dive boat, proper legal permission to operate a small boat may be required for conducting such a survey. Due to its entrance to the European Union on May 1, 2004, laws regarding the permission to operate a motorboat in Slovenia changed from the original mandate whereby a foreign national required a special Slovenian issued “temporary boat handler” permit. Prior to May 2005, this temporary permit was required, regardless of home country license. However, at the time, days prior to the survey, the law changed, permitting foreign citizens to drive a small boat using their home country’s boat handler license.

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<sup>87</sup> Based on initial visits and meetings, it was thought that this project would collaborate with the University of Koper, and the resident underwater archaeology group, but this was not to be the case.

<sup>88</sup> This was a suggestion of local collaborators and ‘friends of the project’ who indicated that such non-disturbance research methods would help facilitate official permission.

<sup>89</sup> See appendix for official paperwork regarding permission and collaboration.

### 5.1.5 Underwater Survey Equipment, Storage and Project Headquarters

While scientific diving projects are most beneficial when based in a scientific facility dedicated to such underwater activity, this feasibility study was afforded no such luxury. The institute of marine biology, based in Piran, houses the major scientific diving facility in Slovenia, however, because this facility was not available for collaboration, cooperation with a recreational or educational dive center was deemed the most appropriate course.<sup>90</sup> While one local sport dive center in Piran was not interested in collaboration, the smaller dive center “DC Sharky” based at Bernardin Harbor in Portorož, was the eventual logistical base for this project.

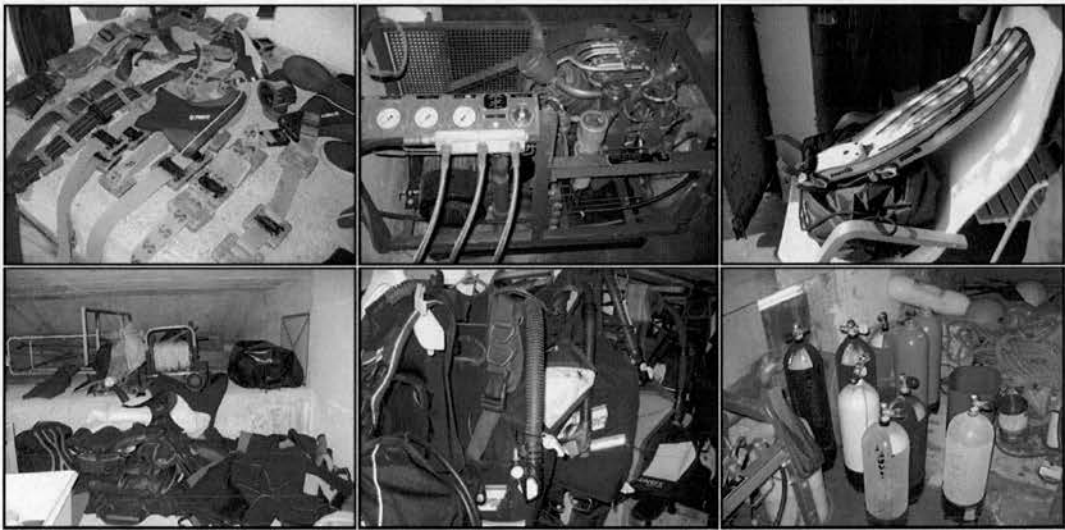


Figure 5.14 Underwater archaeology is equipment intensive. From top left to bottom right, equipment used on a daily basis for the survey: Weights, Air compressor, Fins, exposure suits, Buoyancy Control Devices, and 12L & 10L Compressed Air Tanks (photos by author).

### GPS and sonar

The ability to take detailed geographic positions has recently become more accessible to archaeologists through commercial availability Global Positioning Systems. Use of such equipment is now common during archaeological fieldwork, since equipment costs have fallen dramatically in the last decades. Previous

<sup>90</sup> Based in either Portorož, or Piran, there were two recreational dive centers in the vicinity. Additionally, there would have been options to discuss a possible partnership with a dive center in either Izola or Koper if necessary.



generations of underwater archaeologists did not have the technology to plot locations with satellite positioning and despite the difficulties of GPS use to underwater environments, this was essential to test the presupposition model. A discussion of practical GPS application to underwater survey is addressed later in this chapter.

Sonar provides an acoustic measurement of depth and seabed profiles as well as changes in landscape made visible on a monitor. Sonar, in the form of an echosounder, was essential in attempting to identify areas of interest such as submerged banks as suggested by Fischer (1993, 1995). Embankments were sought to investigate potential paleocoastlines during transgression. While bathymetric data available on nautical charts indicate approximate areas of depth and steepness of banks, there is no substitute for actual measurements in the field. This is especially true when working with low resolution bathymetric charts. Thus sonar readings confirm nautical charts and add precise bathymetry, which can be used to reconstruct paleocoastlines and show areas where divers may find archaeological material (Fischer 1995).

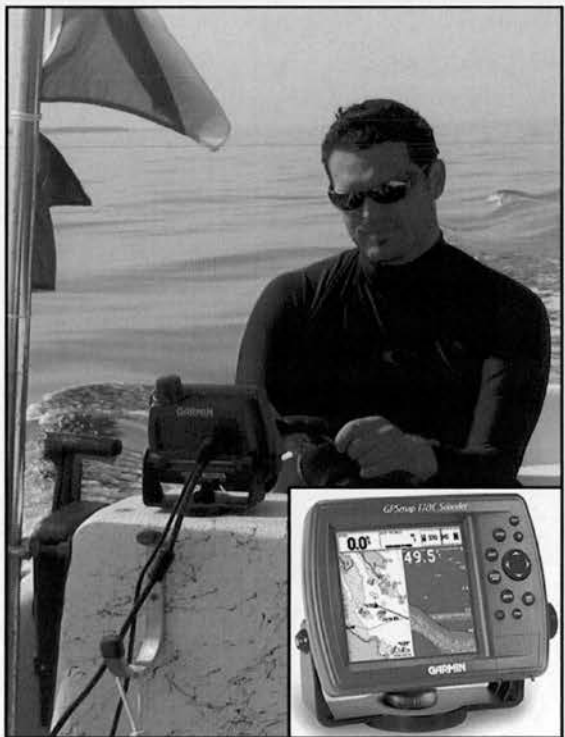


Figure 5.15 A Garmin *GPSMap178C* was used for Sonar and GPS readings. This was important to establish and document survey locations (photo by D. Shefi).

Although there are more accurate types of GPS<sup>91</sup> the commercial products available for this project required a reasonably priced unit to include: GPS, sonar, mapping software for the northeastern Adriatic Sea, and data/record storage features. An affordable solution was the commercially available Garmin 178C with internal antennae. The built-in Sonar was connected to the dual frequency (200hz-50hz) transducer and the depth was displayed on screen along with GPS location. The unit was installed in front of the boat's steering wheel (fig. 5.15), calibrated to marine/salt water and was powered by the boat's own 12 volt battery. Working on the sea, with no obstructions of satellite signal, the unit regularly had ideal signal-condition for GPS readings, yielding a margin of error of  $\pm 4\text{m}$ . Such a margin of error would be too great for archaeological fieldwork in which mapping individual finds or features is required. However, because the primary goal of this study was to locate potential sites the margin of error was acceptable.

### **Dive boat**

A dive boat was perhaps the most important logistical consideration for the project. Without a functioning platform from which to conduct diving operations, the survey would have been impossible. Primarily, a dive boat needed to accommodate the weight of a minimum of four divers and equipment for a full day of diving. The size of the boat was important not only for comfort, but to provide space for numerous tanks and the crew, without the risk of injury caused by moving heavy equipment. Dry storage space was also important for record keeping, medical equipment, food and water. Additionally the power of the boat's motor was a consideration. The speed of the loaded boat was important as it determined how quickly the team could receive medical care, or escape the onset of bad weather.

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<sup>91</sup> such as 'DGPS' (e.g. [www.garmin.com](http://www.garmin.com)).

Cost of boat hire during the busy season of a coastal community can be a major problem.<sup>92</sup> Once on the ground in Slovenia, it was initially arranged through a local sailing club to hire a 5m rigid inflatable with a small engine. This was a minimally functionally boat at an accessible price. Fortunately, due to local contacts made through the diving community an ideal dive boat became available.<sup>93</sup> The project was granted access to a 21 foot Carolina Skiff planning vessel with 50 horse power outboard motor.<sup>94</sup> The vessel was an excellent solution for the needs of the project and provided safety, stability, space, and speed. Installation of the GPS unit and sonar transducer was completed while the boat was at the harbor.<sup>95</sup>



Figure 5.16 The dive boat at anchor in Bernardin Harbor. The working platform was safe and efficient and an essential part of the 2005 survey (photo by author).

### Underwater survey equipment

<sup>92</sup> An initial attempt by email communication with a boat rental agency resulted in a quote of 5000 Euro, an obvious indication of an opportunistic industry geared toward tourism.

<sup>93</sup> After email correspondence and some negotiation, the project was granted access to a boat owned by the University of Vienna, Austria department of Marine Ecology.

<sup>94</sup> In exchange of a small fee and a trade of boat maintenance.

<sup>95</sup> The 7m Carolina Skiff, a keel-less working platform, housed a Evinrude engine and was kept in the small harbor at Bernardin. This situation was made possible, and free of cost, as a result of our affiliation with the dive center. Fuel costs varied from 5000 to 15000 Slovenian Tolar (about £15 - £45) weekly, depending on destination of dive sites, and sea state.

Each member of the survey dove with their exposure suit,<sup>96</sup> a full SCUBA unit, with a primary and reserve air supply, a mask, and fins. Additionally, for documentation of bottom composition, currents, visibility, and any archaeological material, a writing slate and pencil were standard equipment. A common diver's reel with a 50m line was also a standard piece of safety equipment and was attached to both the diver and a surface marker buoy. This allowed divers to be located and monitored via the buoy, in addition to the diver's air bubbles. A digital camera with underwater housing was used on the majority of dives for photo documentation.<sup>97</sup>

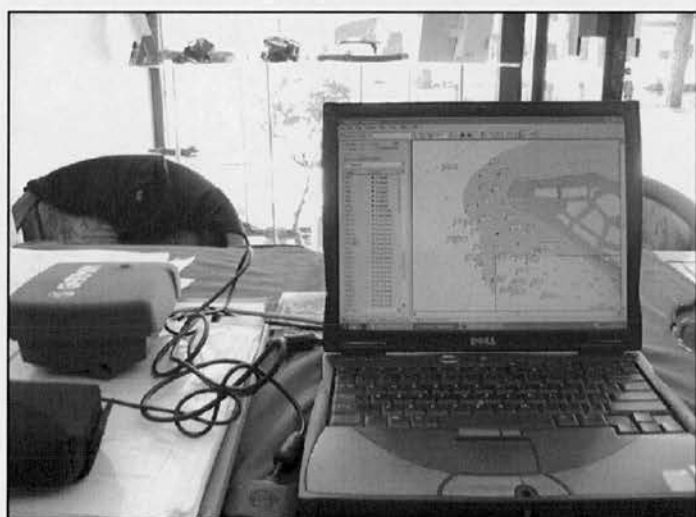


Figure 5.17 A PC laptop transferring data to and from the GPS unit. These were housed in the office, and updated daily both to record survey of locations and to plot future dive sites (photo by author).

A classroom at DC Sharky was converted to a temporary office headquarters for the survey team and used to house valuable technical equipment. A PC laptop was required to plan and log dive sites using the Garmin Mapsource/Bluechart GPS software (fig. 5.17). Other equipment housed in the office included a scanner, printer and laminator. The scanner was used to scan nautical charts, which enabled magnification and cropping sections of the charts, after which the laminator was used to protect charts and other paperwork, such as the documentation of governmental permission; this made them both portable and water-resistant. These documents were regularly carried onboard the boat during the duration of survey.

<sup>96</sup> generally 5-7mm wetsuit, and gloves for additional warmth as well as protection.

<sup>97</sup> Cannon S500 5.0 megapixel camera with Cannon WP-DC800 housing.



Rope was an important tool both for survey methods and safety. A 10m 'buddy line' was used to physically link the two surveying divers. This allowed divers to focus confidently on the survey while able to locate the direction of their survey partner at a glance, regardless of visibility. A 100m rope was used for linear survey, and kept on a garden hose reel, to keep the rope from tangling. Two surface marker buoys were attached to the ends of the 25m ropes via a counter balanced pulley and weight system (fig. 5.19). The use of rope, weights, and the pulley system during the survey was important for taking positions with the GPS equipment and will be discussed in greater detail.

Prior to the first dive, safety considerations were in place for possible emergencies during underwater survey. A continuous-flow oxygen kit was on board the boat throughout the project. Additionally a first aid kit was maintained ready for use. Due to the nature of the area surveyed, a VHF radio was not necessary for emergency communication. Mobile phone access from Slovenian, Italian and Croatian signals was regularly available and multiple mobile phones were kept in a dry box on board. Additionally, the Slovenian Naval hyperbaric chamber was available to the survey team in case of decompression sickness, or a diving incident requiring medical attention.

### **Local participation and regional familiarization**

Discovering archaeological material underwater is most likely to be accomplished by surveyors who are both competent divers and familiar with local archaeology (Muckelroy 1978). Given limited time underwater and the added difficulty of underwater identification, such familiarity with regional material is essential.<sup>98</sup> For this reason, surveyors visited the *Pomorski Muzej Sergej Mašera* (Piran Maritime Museum), *Narodni Muzej Slovenije* (National Museum Slovenia), *Arhaeolški Muzej u Zagrebu* (Archaeology Museum Zagreb) and the *Arhaeolški Muzej Zadar*

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<sup>98</sup> Since the core team of surveyors was from the USA, UK, and Ireland, learning the archaeological material of the Adriatic region was an important step.

(Archaeological Museum Zadar).<sup>99</sup> Finally, during the first week of survey, the June staff was invited to the department of archaeology in Ljubljana, at which time a collection of Slovenian ceramic finds were made available for familiarization. This proved very useful for the identification of local ceramics.

An educational approach was taken by the team while at headquarters in Bernardin with an objective to establish and encourage underwater archaeological survey as a standard, both within communities of non-diving archaeologists and sport divers. In addition to the core group of surveyors from abroad, the team was enhanced by two members of the Slovenian Navy.<sup>100</sup> Securing this level of regional expertise was immeasurable to the team.<sup>101</sup> Aside from assistance and underwater professional training, local Naval divers contribute regional expertise in local seafloor conditions, prevailing currents, and local 'gossip' about dive sites. All these elements can be important to an underwater archaeologist, particularly when foreign to the region of study. Naval divers were not the only helpful locals who assisted the archaeological survey. Sport divers were encountered on a regular basis, and were continuously encouraged to report finds of archaeological interest to the local museum or underwater archaeologists. Some local sport divers became interested enough to assist the team with survey, helping with equipment on the boat and other daily logistical needs.

In keeping with the goal to encourage the technique and ideas for Stone Age survey in the Adriatic, two lectures were held by the author in Slovenia and Croatia.<sup>102</sup> This presented a different approach to prehistoric survey the local archaeological community. This was effective in engaging the community and led to increased interest and future collaboration. Additionally, such communication with the

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<sup>99</sup> In addition to those museums listed, the author also visited the Archaeology Museums of Novo Mesto and Koper (Slovenia), and Umag (Croatia) as part of the regional familiarization process.

<sup>100</sup> Staff Sergeant Ladislav Celestina and Sergeant Jernej Celestina.

<sup>101</sup> Naval divers are professionals in underwater search technique and the project was enhanced by the practical input of ideas and in-field assistance. One such example was testing the 100m swim-line method discussed later in further detail.

<sup>102</sup> Archaeology Student Conference, Stačo Vas May, 2005, hosted by Ljubljana University, department of Archaeology. Lecture by invitation, department of Archaeology, Zagreb University June, 2005.

archaeological community provided the opportunity for a variety of specialists to become aware of a different approach to the archaeological survey of a particular region and add their thoughts.<sup>103</sup>

Underwater archaeological survey is a multi-disciplinary exercise in its very nature, and experts from other fields are essential to an understanding of any region from a holistic scientific approach. While on location, during the spring and summer of 2005, discussions between the author and members of the University of Trieste, department of marine geology, the Piran aquarium, and marine biology station in Piran, local ship builders, maritime police, and harbor patrol and fishermen took place. This step, part of regional familiarization, is key to understanding the many variables: physical, logistical and academic, which can impact an underwater archaeological survey (Fischer 1993).

#### **5.1.6 Weather Conditions**

Despite the fact that coastal Slovenia is a summer resort destination, Istria can be subject to wet and windy conditions even in the 'high-season'. This was the case for much of the summer of 2005 (fig. 5.18). Between June 4 and July 29, 2005, at the time of the survey, low pressure brought thunderstorms storms and/or gusting winds for a total of 42% of the time (11 days out of 26) in June, and 45% of the time (13 days out of 29). While thunderstorms and significant rainfall along the coast of Slovenia are not uncommon during the late spring, the summer of 2005 was a particularly wet season.

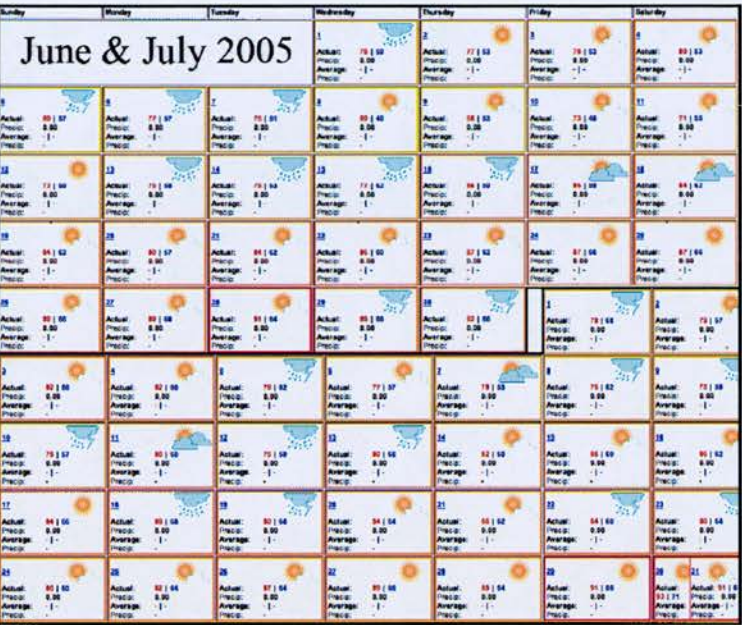
Weather can become one of the most important variables for an underwater survey, particularly in locations at which off-shore dive sites require the use of a boat. Safety must be the primary concern, and weather conditions can compromise safety. Winds, especially the *Burja* (Bora), can cause a significant movement of water along the Adriatic, and make exit and re-entry to the dive boat difficult and dangerous.

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<sup>103</sup> Underwater archaeologists from Denmark, Italy, Slovenia, and Croatia were consulted on the survey prior to and during its undertaking and provided their insights, both supportive and cautious.



Therefore during windy days when safety was compromised, diving was either cancelled, or relegated to sheltered near-shore areas.<sup>104</sup> Because of the unpredictable



workday.

weather conditions, diving plans were often adjusted each morning. This both affected the geographical diving locations, and added a psychological element of difficulty for the survey team, which did not know the dive schedule until the morning of the

Figure 5. 18 Weather data collected at the international airport of Portorož, indicates that stormy conditions were common in the summer of 2005 (© Weather Underground Inc.).

Another important consideration affected by weather, and wind, is the accuracy of positioning the boat for GPS readings. Anchoring the boat properly should keep the small vessel from straying off point, however, as often the case during strong currents or winds, the seabed composition was simply insufficient to keep the boat from dragging anchor and wandering. Additionally, to achieve the maximum accuracy from the GPS reading it is preferable that the boat remain still for several

<sup>104</sup> During unfavorable conditions sites that were safe for diving, however of lesser potential for prehistoric material, were often surveyed.



seconds while the receiver acquires its current position. Poor conditions can compromise these measurements if proper care and confirmation is not practiced.<sup>105</sup> It was also important that the surface marker buoy is resistant to such weather conditions, as discussed in greater detail later in this chapter.

Winds can directly affect underwater conditions for survey, and oftentimes, following a strong wind, the survey was affected by decreased visibility. Strong currents can also cause problems for divers,<sup>106</sup> though this impacted the survey irregularly. Finally, weather conditions can have a significant financial impact on a survey. Fuel costs for a dive boat can vary depending on weather and sea state. Choppy conditions caused by wind amount to greater resistance on the water and require more fuel. Therefore in addition to constituting a safety consideration, weather is a financial consideration. This is especially true if days are lost in result of bad weather, or the survey time is extended, adding additional living and equipment hire costs.

## **5.2 Original Fieldwork: Methodology & Survey Locations**

Original Field Survey began on June 6, 2005. The project was obligated by law to report all findings of archaeological significance to the *Zavod za Varstvo Kulturne Dediščine* (Institute for the Protection of Cultural Heritage) consulted on this matter. The Institute along with the museum Pomorski Muzej Sergej Mašera later agreed that selected finds be surfaced and brought to the Maritime Museum in Piran. Testing a variety of survey methods was anticipated for the success of this project, and adaptations to the local conditions were considered a part of the project plan and goals. The methodology and results from this survey are discussed herein.

### **5.2.1 Survey Methods**

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<sup>105</sup> As is standard practice for the safe recovery of divers, the boat handler maneuvers the vessel against winds and current to keep from drifting over the divers. This was also the method for achieving maximum accuracy in GPS recording of a survey site.

<sup>106</sup> This was the case during dives on July 20, when currents on the north side of Piran were so strong that divers had to swim hard to keep from drifting westward.

Teams of two SCUBA divers surveyed underwater on a rotating basis. At all times, two members of crew remained on the boat to ensure diver safety and to document activity and observe diver location by the surface marker buoys and diver's bubbles. Additionally the staff was prepared with dive equipment to assist in case of an emergency as the team rotated diving in a pattern of two-up, two down. The two-up, two-down scheme was multi functional, as both a safety measure and as surface interval time, which is necessary when conducting multiple SCUBA dives during a single day.<sup>107</sup> The use of dive tables to plan dives is a standard practice in professional and recreational diving for assessing maximum bottom times at a given depth and the necessary surface interval times between multiple dives in one day. As a safety precaution, conservative 'recreational' dive tables were consulted. This measure was taken to ensure minimum diving-related risk to the underwater surveyors.

The two primary search patterns employed were linear and circular survey methods. In all cases, GPS locations were taken from surface marker buoys, using the onboard GPS/Sonar unit. This process is discussed in detail and shown through diagrams to depict the survey methods conducted during the 2005 survey season.

### **Linear / jackstay survey**

A linear, jackstay survey pattern was conducted by using two surface buoys, each attached to a 15kg cement weight and connected by a 100m negatively buoyant rope. A pulley and counterweight system attached to the underside of the surface marker buoy ensured a taut line (fig 5.20). The marker buoy would thus float vertically above the cement weight which would be recorded as by GPS. The pulley and counterweight system allowed for varied depth of the marker buoy, as well as fluctuations caused by wind, and the undulating sea. The 100m horizontal line on the

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<sup>107</sup> Although the purpose of this dissertation is not to discuss dive theory or the physiological effects of SCUBA diving, there is an element of chemical and physical consideration which any underwater archaeologist must be aware of and plan for accordingly.

seabed allowed the surveyors to follow the desired survey path without having to focus on underwater compass readings, and for proper documentation of the area surveyed.

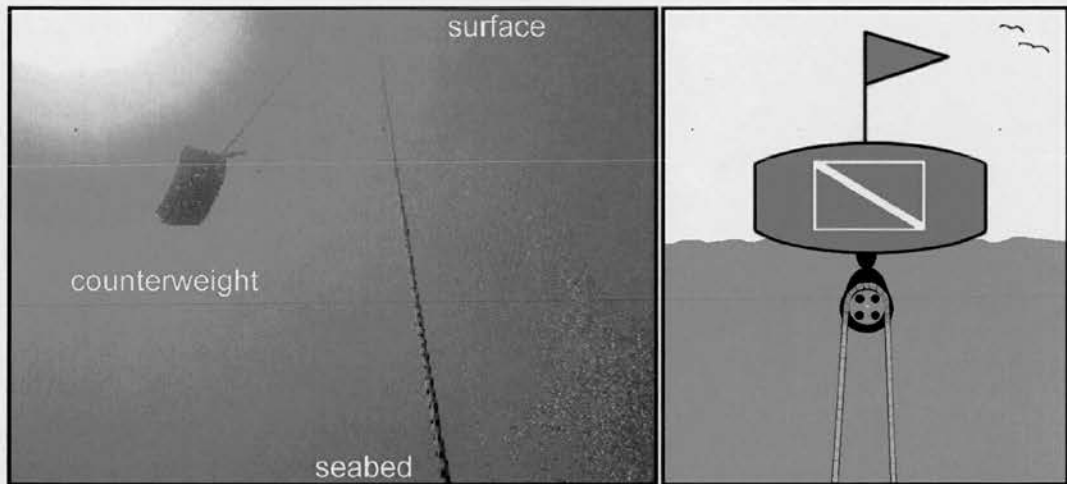


Figure 5.19 The pulley and counterweight system worked by pulling the surface buoy line taut and vertical over the 15kg cement weight. This enabled the most accurate GPS reading possible to record the survey areas.

Initially, two divers surveyed in a linear pattern, each on either side of the rope in a 'single jackstay' technique. During linear survey, divers were connected by a 10m 'buddy-line', using a positively buoyant rope. This positive buoyancy prevented the rope from dragging and catching on the sea bottom and attached to the diver's vest with a marine clip. The buddy-line was used to ensure directional survey, and as a safety measure to prevent accidental wandering. Additionally, this served as a method of communication by pulling the rope if something of interest was found, or a safety issue arose.

The single jackstay survey pattern along the 100m line was quickly replaced by a more practical 'double jackstay' where both divers survey on a single side of the line. The team generally had enough time and air at 20m depth to survey both sides within the 35 to 40 minute dives. The double jackstay method reduced the need to constantly move weights and rope, while effectively doubling the area covered from 100m x 20m to 100m x 40m (fig 5.20). This technique was conducted on all dives in



the central gulf, as well as on several dives near shore and was considered the most efficient method to search for archaeological material as well as noteworthy topographical features.

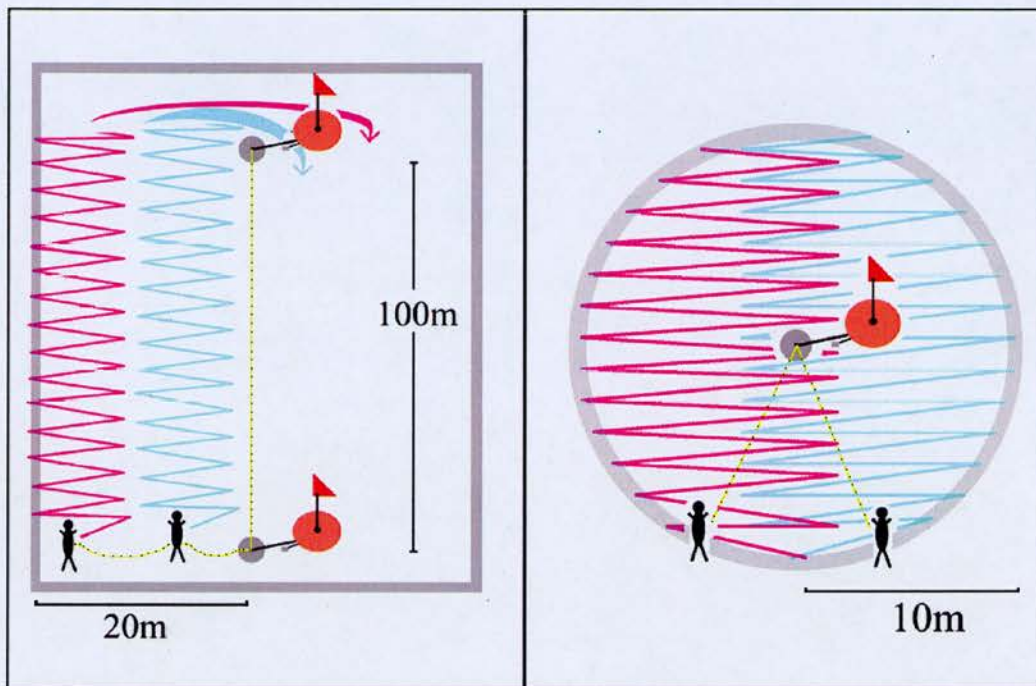


Figure 5.20 Diagrams of the two primary methods of survey conducted (left) Linear survey involving surveying both sides of a 100m line was employed when a large area was desired (right) Circular survey was employed when a more detailed search was required, there was a large quantity of material or landscape was not appropriate for a linear style survey, such as a sloping bank.

### Circular survey

At survey locations at which 100m of linear survey was not appropriate,<sup>108</sup> a close cover, circular survey was employed (fig. 5.20). A diameter of 20m was covered by each circular survey. Although divers were not directly connected to each other using this method, each diver was connected to the center marker weight by a single rope, clipped to the centerline in the middle of the dive rope and to each diver at the ends. The buoyant rope, arched upwards off the sea floor prevented snags. Additionally, in case of need, each diver had access to his or her partner by

<sup>108</sup> When diving in areas at which the seabed was cluttered with debris, or topography of the seabed was sloped, linear survey was not efficient and circular, close cover survey was conducted.



following the rope regardless of visibility. Each diver surveyed a side of the circle, starting at the deepest point and swimming in a zigzag pattern. This survey, managed in distance by the extent of the rope, allowed a more thorough close cover survey of the 20m diameter by both divers, as overlap would often occur, allowing the given area to be thoroughly investigated.

### 5.2.2 Survey Locations

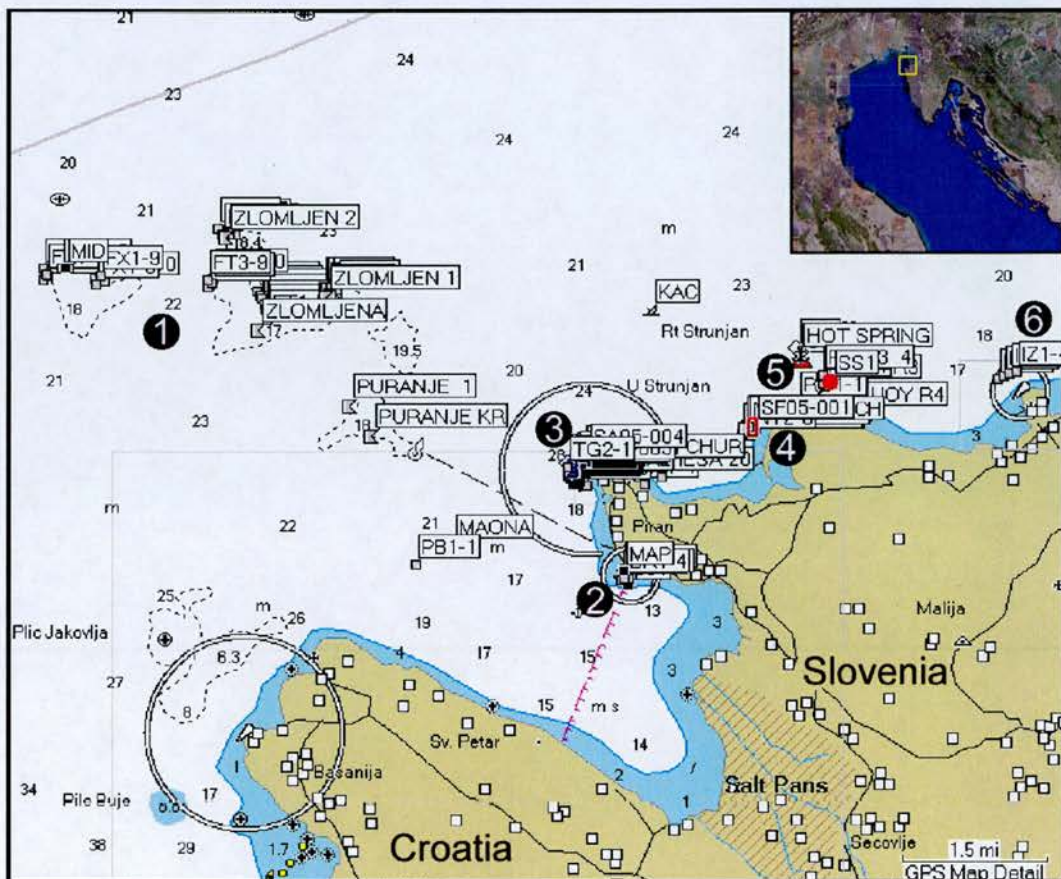


Figure 5.21 GPS map with key survey locations. Key areas of interest described herein: 1) *Brajde* ('Gulf features') 2) Bernardin 3) Punta Piran 4) Strunjan 5) Ronsek 6) Izola (The Kac and Maona are 20<sup>th</sup> Century military wrecks).

Survey locations and relevant aspects of each area are discussed below. Relevance according to the theoretical model and actual results are also discussed. Results of the survey, including seabed composition, currents, and other and conditions are also noted. A discussion on specific archaeological material is found after the description

of locations surveyed. Additionally, all information regarding exact dive locations, times, dates, and personnel were documented and recorded in a comprehensive dive log.<sup>109</sup>

### **Piran Bay Middle**

According to the 1:75,000 scale nautical chart, it was thought that the 20m contour located at the perimeter of the bay of Piran might indicate an area at which transgression would have produced a now-submerged strait (fig 5.21, 'PB1-1'). This would fit the model as an area appropriate for prehistoric human activity, including construction of fish traps and shellfish collection (Fischer 1995). The result of the survey showed that the silted, muddy bottom is actually flat, and contrary to the nautical chart's depiction, does not indicate any kind of submerged strait. Currents were relatively strong, moving from west to east. This was the first indication that the coarse scale of this chart might be too general and lack sufficient detail.

### **Point Bernardin**

Located at the head of the Bay of Portorož within the greater Bay of Piran, Point Bernardin was originally noticed as a south-facing point, protected from northerly winds. Indeed both modern and Roman inhabitants (Gaspari 2005) have profited from this advantageous location. At approximately 10m – 12m depth, offshore from the point of Bernardin, the location would have been appropriate according to the survey model. However this initial speculation neither incorporated the troublesome sedimentological aspects nor the nearby modern construction of the Bernardin Resort and harbor, which added the element of severe modern human disturbance. Thus, dives conducted in front of Bernardin were used for personnel training and refinement of survey methods.

### **Fiesa Bay**

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<sup>109</sup> See appendix.

This small bay between Piran and Strunjan Bay is the home of a small reef, which is a steep rocky ledge from about 5m – 9m depth. It was chosen as a potential site because of its location near a bay and a small valley, wherein a fresh water creek may have existed. Its 20m contour, the original point of interest, however, was not a defined topographic feature but rather flat and devoid of any archaeological material; another example of the inaccuracy of the coarseness of the nautical chart.

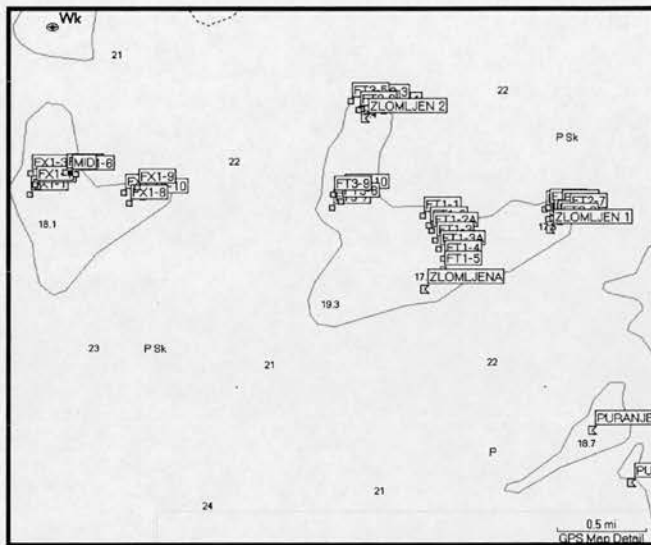
### **Izola**

The modern town of Izola is built on the only non-flysch on the Slovenian coast (Pavšič & Peckmann 1996, fig. 1) utilizing what was once a limestone island. Originally, the potential interest in this area was the prospect of less sediment, as the locals speak of the beach at Izola as having the “clearest water” on the coast. It was thought that the limestone might have influenced bottom composition and visibility. However, the survey showed that the 15m contour was featureless, both flat and heavily silted with gray mud.

### ***Brajde* (gulf features)**

The Brajde feature’s name refers to a field of sea grasses, which used to grow on these elevated areas of the central Gulf of Trieste. The Brajde features are 5m shallower in places than surrounding gulf sea-bottom as indicated on the 1:75,000 chart. The features therefore posed the potential of submerged landscape discovery, and were interpreted as potential islands submerged during times of transgression. Additionally, sediment deposition in the central gulf is much less compared to nearshore environments since it is situated further from coastal rivers and lagoons. In this area of the gulf, the seabed is predominantly sand, while silt and clay are much scarcer (Ogorelec *et al.* 1991, fig. 3). The published data was confirmed by observation.





The central gulf features were surveyed in two areas of focus (fig. 5.22).<sup>110</sup> While contours on the nautical chart indicate a sloping area from 17m to 23m, a difference of 5m, it was thought that if there existed a steep side of either of these features, there might be evidence of a submerged paleosol and transgression, and effectively be a good location at which to search for prehistoric human activity. Based on late Stone Age shellfish exploitation on islands in northern Europe (Bonsall 1996), the *Brajde* locations, had they been exposed land surfaces during the early Holocene transgression would have been prime areas for shellfish collection. According to the survey model, sea levels and transgression dates (Lambeck *et al.* 2004), and the lack of sediments (Ogorelec *et al.* 1991), this area, was considered high potential and of notable interest.

The survey of Brajde features in the middle of the gulf, however, produced only negative data. The nautical chart once again proved too coarse, when in reality there were no pronounced banks to indicate original land surfaces. Though the bottom was composed of sand rather than silt, nothing of archaeological value was found. It is also very possible that extensive shellfish dredging and fishing with trawling nets, affected the submerged landscape and any archaeological remains previously

<sup>110</sup> *Zlomgena Noga* (meaning ‘Broken Foot’) and ‘Fox Head’ were the names affectionately given to the two features by the survey team.



present. More environmental and (possibly archaeological) information could come from additional core sampling.

## Triglav

Triglav is located only a few hundred meters north west of the point of Piran and is the deepest point in the Slovenian Adriatic Sea at 38m. According to a local geographer and underwater enthusiast the area of Triglav consists of both silt and sandy bottom compositions, which varies depending on currents (Žumer, pers. com.).<sup>111</sup> The single dive conducted for this survey, to assess the bottom composition, resulted in observations of a seabed consisting only of muddy silt at a depth just shy of 37m. The survey was restricted to one dive, kept short for safety purposes, which proved archaeologically uninteresting.

## Ronek Point

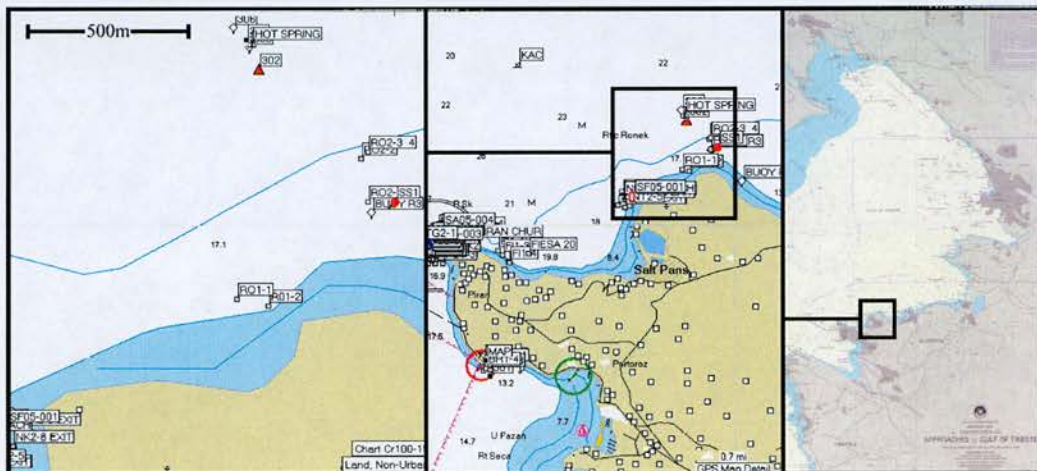


Figure 5.23 GPS map of Ronek Point relative to the Gulf of Trieste. Survey locations of Strunjan point are also visible (bottom left).

The shallow nearshore waters of Ronek Point are between 0.5 – 2m depth. The point itself is a rocky cliff, that drops off quickly to a beach of sandstone shingles and sand. The nearshore environment is a rocky reef, which drops steeply to a muddy

<sup>111</sup> J. Žumer, geographer, diver (see bibliography for referenced publication).

bottom. A raised area of land, called *Bronica* (fig 5.24 ‘*plitvina*’), and may show a submerged paleosol in the form of a hill or, at some stage, a small island. Fossilized *Cladocora caespitosa* coral have been found under the surface at 17m – 20m (Žumer 1990). The mound-like feature may have been a submerged island, however survey found only modern rubbish, and a silted, muddy seabed. Any further archaeological interest in the area would require test excavation and extensive cleaning of the silted, muddy seafloor. This time-consuming and expensive practice may be difficult to justify without initial evidence of archaeological material recovered from archaeological survey.

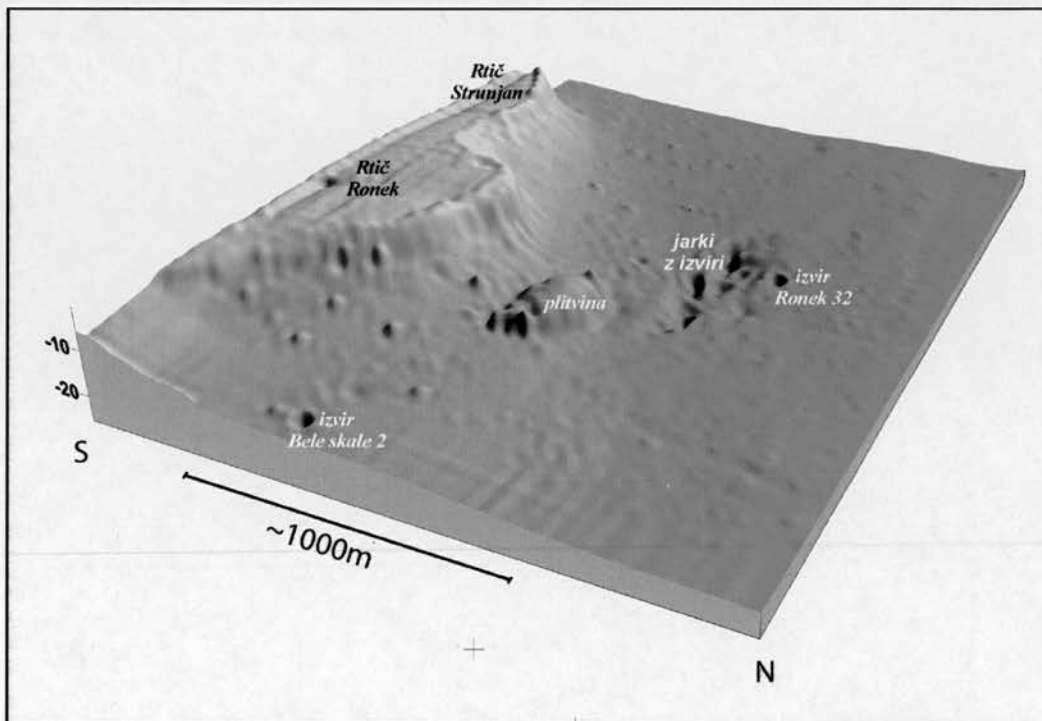


Figure 5.24 A relief of the submerged environment offshore from Ronek Point (Rtič Ronek) illustrates an elevated area in the nearshore (*plitvina*) as well as the submerged spring (*izvir Ronek*) at a depth of 32m (image courtesy J. Žumer)

Another potentially interesting feature from a geomorphologic perspective, is the submerged hot springs in this area near Ronek (fig. 5.24 ‘*Izvar Ronek*’). The flysch coast has a number of such hot springs according to Benac (2003) who studied a similar feature in southeastern Istria, Croatia. From an archaeological perspective, such a natural hot spring would have likely been a point of interest for prehistoric

groups. This geological and hydrological feature was surveyed for archaeological potential. The hot spring is a 32m deep sinkhole is located only 900m offshore from point Ronek surrounded by the seabed at 24m depth. This offshore spring was deemed to be archaeologically insignificant. It is also possible, and perhaps likely, that the location of this spring, had it existed in the early Holocene, differed from its current location (Benac 2003).

### **Strunjan Point**

The nearshore of Strunjan Point was originally surveyed to investigate areas mislabeled on the 1:75,000 chart. The chart indicated a depth of 15m while sonar readings showed an actual depth of approximately 19m. This preceded a steady grade from 19m to 15m, then a notable bank toward shore at 15m up to approximately 8m, before a gradual slope toward the beach. Initial sonar measurements seemed promising for testing the survey model. However, evidence of prehistoric human activity would most likely be buried under the thick silt, a result of the near shore flysch cliffs, and sediments from the soft clay marls.

While the bottom is composed of silt >12m depth, the shallower areas, at <8m, are significantly less influenced by the silt, and mostly sandy in composition. This is possibly a result of currents caused by strong winds, affecting especially shallower areas of the first few meters of the sea (Malačič 2003). The seabed in the shallow nearshore waters is sandy with sea grasses emerging at <8m depth. Although Strunjan point did not test positive for prehistoric archaeological evidence, there appears to be evidence of a later archaeological feature, previously undocumented. This will be discussed in detail in the finds section of this chapter.

### **Punta Piran**

A significant amount of the time was spent surveying the nearshore waters near the Point of Piran. This headland, the furthest protruding point of the Slovenian coast, was assessed, was eventually determined to be the most probable area for positive



prehistoric archaeological discovery. Piran, a modern Venetian-style town, has been a documented center of human activity for centuries, if not millennia (Terčon 1993) and fits the Danish model, as it is located at the tip of the bay and the end of the headland. Archaeological material recovered from Piran includes the Roman shipwreck salvaged in the 1950's (Bonton-Tome 1989; Knific 1993), and a Roman site that produced artifacts from the middle and late La Tène Iron Age culture (Guštin 1987).

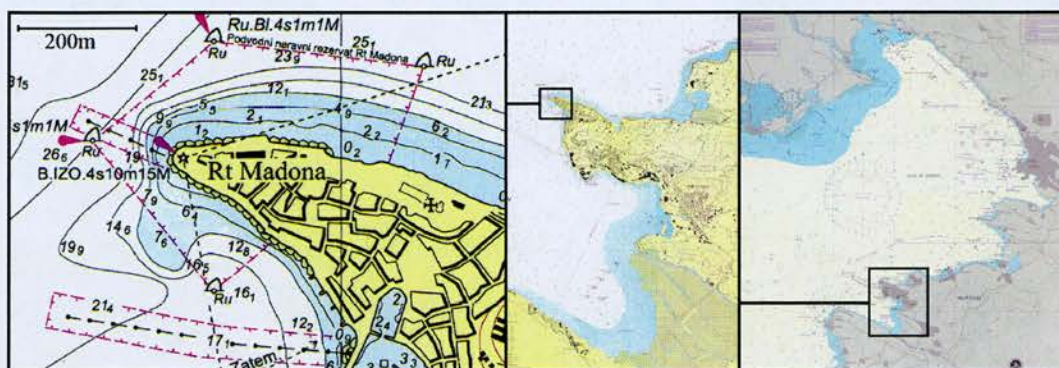
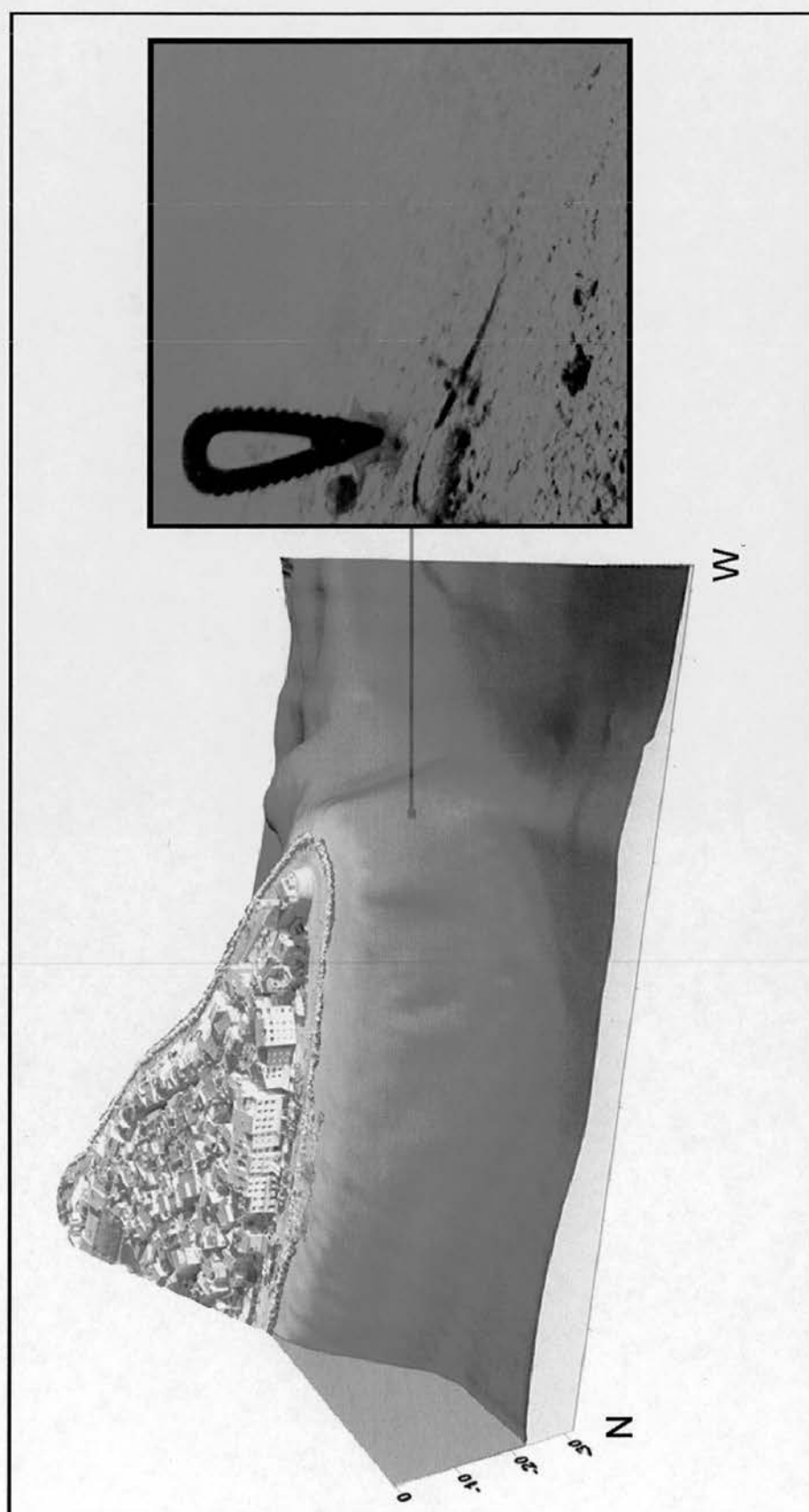


Figure 5.25 Nautical chart of Punta Piran and surrounding waters within the Gulf of Trieste.

Currents from around the Point of Piran range from light to strong, depending on season and wind strength and direction. The Bora winds from the northeast can cause a strong current from east to west (Malačič 2003). This is the case between Piran and Fiesa Bay, where currents sweep westerly across the Point and wrap into the Bay of Piran. Additionally, clockwise swirling currents through the bays along the Slovenian coast can occur, caused by a swirling effect of the predominant counterclockwise current in the Gulf. This appears to have an effect on sedimentation, as material accumulates on the southern side of Point Piran (fig. 5.26). This speculation could be confirmed by core samples, and resulting radiocarbon determinations.

Figure 5.26 (following page) Aerial photo of Punta Piran superimposed over a 3D rendering of the surrounding submerged landscape. The 10cm knife stuck vertically into the seabed shows the steepness on a human scale; the drop is not as vertical as it appears on the 3D rendering. The average slope from shore to 20m depth is approximately  $m = 3:10$ . The 3D relief of Punta Piran was created using a data provided courtesy of Harpha Sea, Koper.





The underwater bank at the point of Piran drops steeply, resulting in a relatively high depth: distance-to-shore ratio. The steepest bank is located directly in front of the headland west of the point, and drops to 20m depth within less than 100m (linear surface distance from shore). To the north, the bank of the slope is more gradual, and includes a reef of sandstone blocks, which forms a ledge from 5 to 10m depth. To the south, the bank is irregular and very gradual before dropping off past the 20m contour further from shore, due to sedimentation, and prevailing currents.

Bottom composition near the point of Piran varies according to depth and location. To the west, directly in front of the point, a sandy bottom with light silt prevails to depths greater than 20m. Along the south side of the point, sediments increase, though there are areas of higher sand and less silt on the southwest of the point. This appears to be consistent with the hypothesis regarding sedimentation and prevailing currents. To the north the silt becomes sparse at 15m depth, while the 20m contour is a muddy and flatter bottom. These sediments become less prevalent further west in the direction toward the tip of the headland.

As a result of centuries of documented occupation and activity, dating back to classical times (Bonton-Tome 1989; Knific 1993; Terčon 1993) and likely earlier (Guštin 1987), the submerged area near the town of Piran, in places, is littered with evidence of cultural activity. Much of this is modern rubbish, although there is datable evidence of ancient material on the surface of the sea bottom. Evidence from both the 2005 survey, and previous expeditions (Knific 1993) shows that ancient material can be recovered from the seabed of the nearshore zones of Punta Piran. This is important in the search of prehistoric evidence underwater, as it indicates that sedimentation does not cover archaeological material under insurmountable layers of silt. In fact, some artifacts remain exposed at or near the surface of the seabed. The presence of archeological material on the seabed near Piran also shows that, though currents can be strong, they do not usually displace artifacts outright.

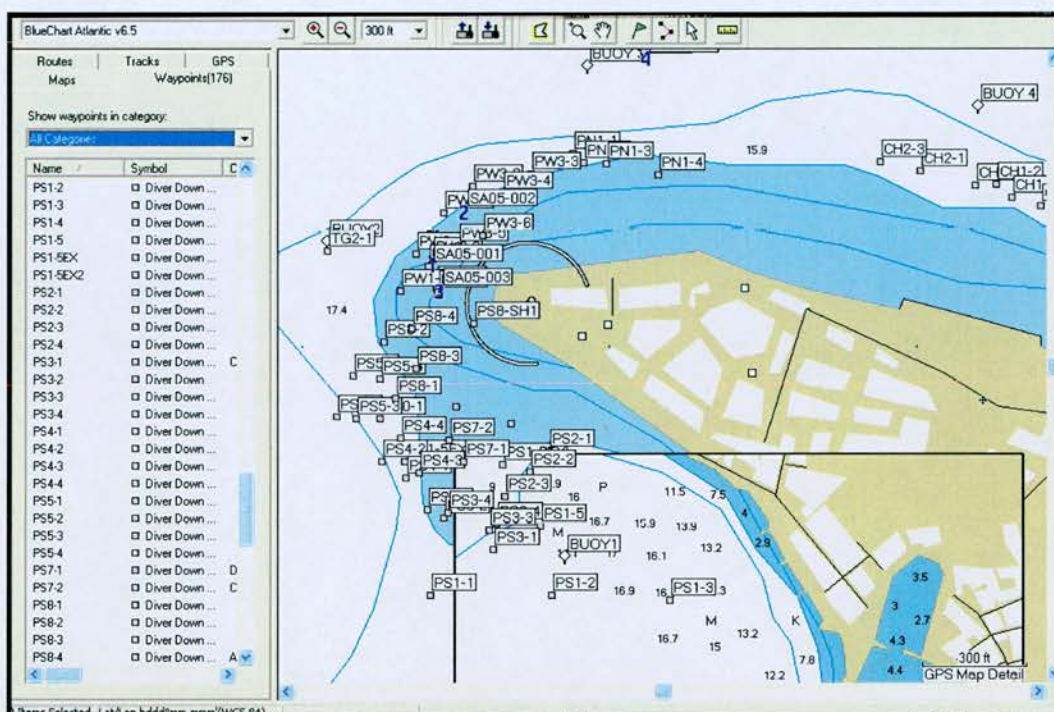


Figure 5.27 A GPS Map of Piran and survey locations as indicated by 'diver down' waypoints. Punta Piran was extensively surveyed, as shown by the list of recorded dive sites.

Due to the number of dives conducted near the point of Piran, the area was broken up for documentation into four groups: Punta South, Punta West, Punta North, and Punta Church.<sup>112</sup> This classification also helped distinguish the difference in areas regarding depth contour, sediments, and archaeological finds.

### 5.2.3 Documentation

Recording the project involved individual project diaries, dive logs, a detailed account of all dive data, and finances kept in spreadsheet format throughout the survey. Daily dive logs were completed by each diver after every dive.<sup>113</sup> This document included a sketch of the location, physical conditions, visibility and currents, and any archaeological finds. Additionally, a log was kept on the boat to track each dive time, including time in and out of the water, and location of the dive.

<sup>112</sup> Dives were conducted beneath the church of Piran located on the northeast cliff at the highest point of the town.

<sup>113</sup> Dive logs were adapted from those used by the Scottish Trust for Underwater Archaeology. See appendix for a complete listing of dive logs and comprehensive details of each dive.



This log was also a safety measure, used to keep track of dive times and resulting nitrogen saturation, and provided data about the individual dives, personnel, and exact times when dives took place. Furthermore, each surveyor was required to keep a daily project log of activities and events.

Buoy positions were recorded as GPS waypoints (fig. 5.27), and logged by buoy number, area code, and day number (e.g. 'PS2-3' was assigned to the second day of survey at Punta South, and the number 3 indicates the third dive of that day).

Position, taken in easting and northing were recorded in WGS 84, as is standard for GPS maps. In the cases of linear survey, entry and exit buoy point were recorded, while single locations were taken for each circular survey. All data was then logged as a hard copy in a notebook, and later input in a comprehensive, master dive log in a digital spreadsheet format.<sup>114</sup> Financial data recording, including equipment costs, air consumption, and fuel costs were tracked using digital spreadsheets. These were updated regularly, and used to reconcile costs with the hire service, and served as a financial report.

### **5.3 Survey Results: Archaeological Material**

Results for this survey can be measured both in the physical archaeological material recorded, as well as in the application of a survey strategy and methods. The tangible archaeological material, context and significance are discussed below.

Implementation of research design and theoretical discussion of future study will be addressed as intangible results of the fieldwork. Although the focus of this feasibility study was on prehistoric underwater archaeological discovery, all archaeological finds, regardless of age, are documented and described herein.<sup>115</sup> Additionally, geological features, which fit the Danish model regarding paleolandscape were sought and recorded. Since areas, not of archaeological relevance were surveyed, the resulting negative data may be considered relevant for

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<sup>114</sup> Included in the appendix.

<sup>115</sup> Artifacts SA05-01 through 04 were handed over to the Piran Maritime Museum in August of 2005, accompanied by an initial fieldwork report.



an evaluation of the survey model and its application within the Adriatic context. The *Brajde* features in the central gulf are an example of negative data; despite favorable conditions of sediments and seabed composition they produced no archaeological material.

### SF05-01

The first feature of archaeological interest was discovered in the form of a stone circle, listed as SF05-01.<sup>116</sup> The feature is recorded at approximately 7m depth and located just west of Point Strunjan less than 100m from shore. The circle of stones measures 3m in diameter and consists of rounded stones 10-30cm in length. In some places the stones are stacked on top of each other several stones high.

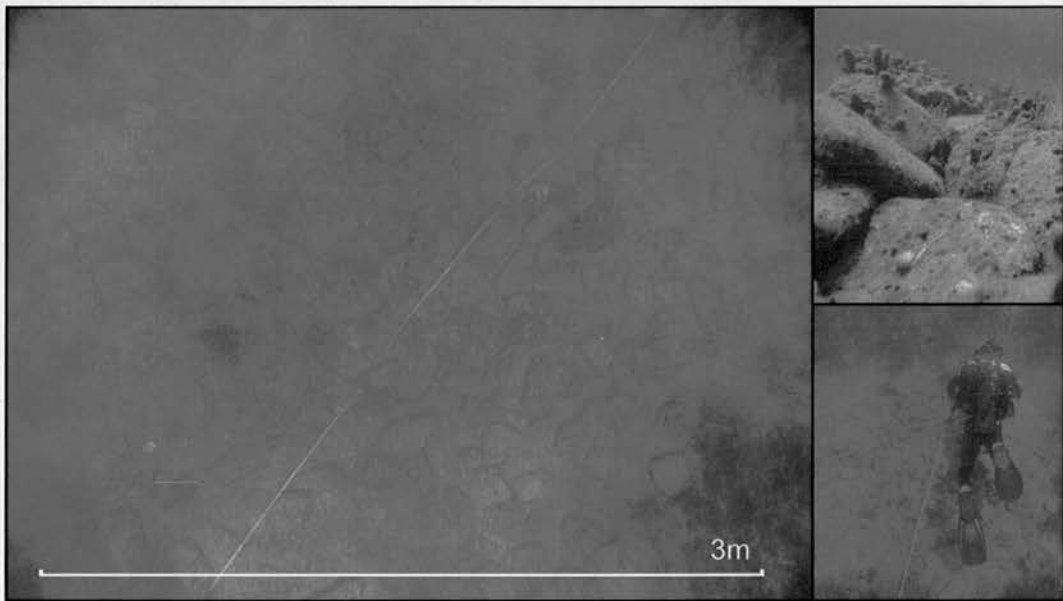


Figure 5.28 Images of the stone circle found near Strunjan. The stone feature stands out on the seabed at depth of 7m and stones are stacked on top of each other disappearing into the sandy seabed. An excavation may show this to feature to be larger than is currently visible as it extends into the seabed, it is not possible to determine size and age without excavation (photos by author).

The stones are found on the sandy bottom surrounded by sea grasses and disappear along the perimeter of the feature, into the sandy matrix. There was no evidence of

<sup>116</sup> The designation stands for “Survey Feature”, year 2005, number 1. Artifacts are designated “Survey Artifact” 2005 and number (e.g. SA05-01).

other stones or features in the immediate vicinity. Sea grass grows at approximately 8m depth and shallower. From 10 to 18m depth, the sandy bank changes to gray mud. Based on the size and shape of stones it is possible that this feature was a ship's ballast (multiple sources, pers. com.).<sup>117</sup> Excavation is necessary for more information to be obtained from this feature. This includes establishing an age, and recovery of any associated artifacts which may be buried under stones. No visibly identifiable artifacts were found associated with this stone feature. Though it is possible that there may be evidence of a wrecked ship underneath these stones. It is also possible that this may be the result of a deliberate ballast dump.

These stones are rounded, not blocks, and appear to be sandstone in composition. Their shape suggests they are not a result of erosion from the nearby flysch cliffs. In the case of such flysch cliffs, clay marls and softer mud erode first, leaving suspended ledges of sandstone (Furlanif 2003). Eventually these ledges succumb to gravity, fracturing in blocks and producing blocky and shingled beaches. Yet, the stones of this feature are rounded, and concentrated in a 3m diameter. Thus this feature appears to be the result of cultural activity. It is possible that through further excavations the feature will be exposed as a larger circle partly covered and underneath the seafloor. Proper excavation is needed to define the archaeological significance of this stone circle.

## **Ceramic artifacts**

### **SA05-05**

This ceramic pipe was the first historical find to be typologically dated (c.19<sup>th</sup> century AD), as evidenced by other finds in Istria (Kovačić 2002; Knific 1993).<sup>118</sup>

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<sup>117</sup> Smiljan Glucevic, Head of Zadar Archaeological Museum, Underwater Division, Croatia; Andrej Gaspari Principal Underwater Archaeologist Zavod Slovenija; Dr. Carlo Beltrame, Underwater Archaeologist, University of Venice, Italy.

<sup>118</sup> SA05-05 was discovered prior to artifacts 1 through 4 and given the assignment of artifact number 5 as a post-fieldwork designation, since unlike the other artifacts of mention, it was not surfaced.

The bowl of the pipe is intact; the stem has broken off, and may have been made from another material, probably wood.<sup>119</sup>

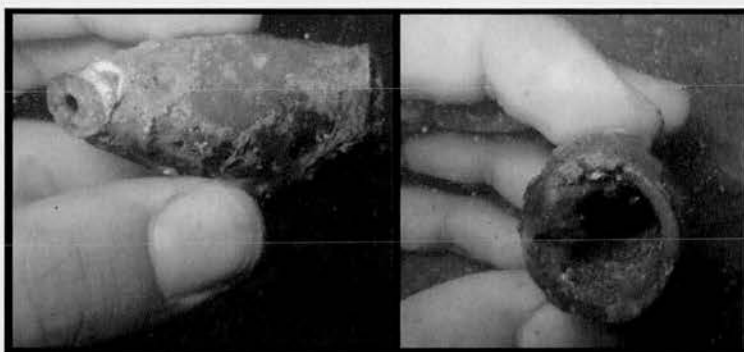


Figure 5.29 SA05-05,  
the head of ceramic pipe.

### SA05-01

SA05-01 is a find of two pieces of a single ceramic sherd, curved, with a reddish brown interior color. The darker reddish brown outside has patches of dark brown and black discoloration, some of which may be from firing, though some of these discolorations are likely the results of marine biological factors. The outer layers of the cross section are reddish brown, while the interior is medium gray with white inclusions. The find measures 7.5cm by 8.5cm (both pieces combined), with thickness of 1.2cm at thickest point of base.

This artifact was found on the west side of Punta Piran. It was discovered on the sandy banked surface at a depth of 12m, partially covered by the light sand. Originally found to be of particular interest because of its darker center of the cross-section, it contains a combination of coarse inclusions and darker discolorations of the exterior. Initially, this find was thought to possibly be non-uniformly, or incompletely, fired. This was based on the color differences of ceramic material. Although it is not, at this time, possible to determine age and origin of this sherd; it was probably been produced on a wheel, and therefore unlikely to be prehistoric. It

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<sup>119</sup> Local fishermen and divers tell of these pipes having been historically used by fishermen, who then discard them for luck once they become clogged (Celestina, pers. com.).

may be medieval, or possibly Roman in age, which would be consistent with previous ceramic artifacts found in the vicinity (Knific 1993).

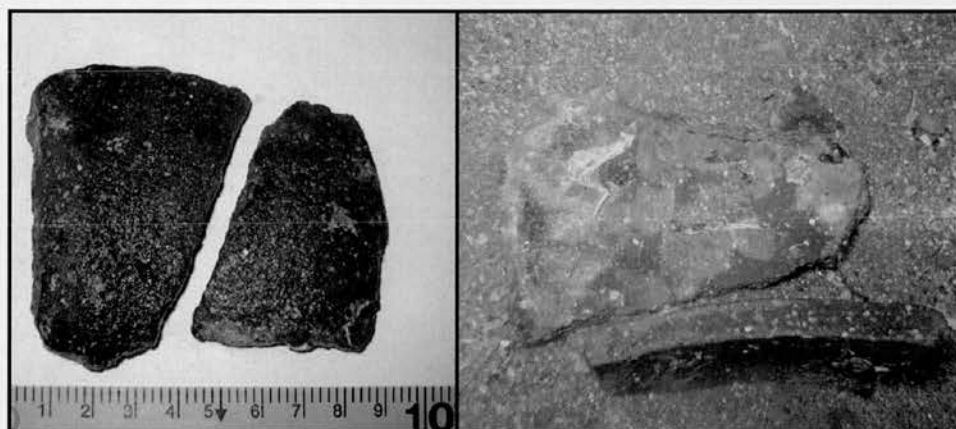


Figure 5.30 Ceramic artifact SA05-01.

#### SA05-02

Ceramic find, SA05-02 was discovered at 11m depth on the north side of Punta Piran. Its original exterior layers appear to have been worn down and internal material is partly visible. A curved bottom and the lower part of the vessel body are present. The find measures 8cm by 5cm (3cm at shorter side) in width, and 1.1cm thickness (at thickest point of base). The sherd was found partially protruding from the sandy bank, approximately 2m deeper than the bottom of the reef, which is just offshore from Piran.

The shape and color of this artifact prompted initial consideration and curiosity. The curve and bottom of the sherd show the size and shape of the original ceramic ware, probably a small bowl. The interior of the cross section shows lighter colored material in the center. This may be the result of poor firing conditions, but could be a result of the conditions of preservation underwater. Numerous inclusions of white material, probably quartz, are present in the coarse composition. In the middle of the sherd is a small hole, possibly caused by marine life.



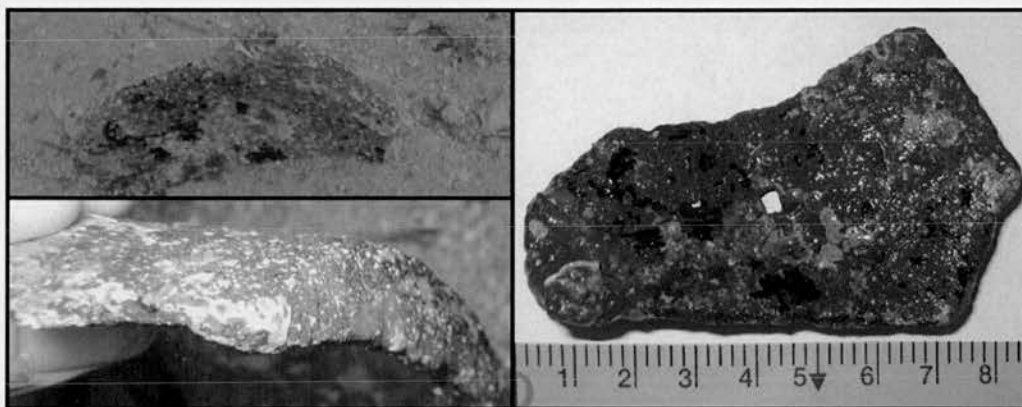


Figure 5.31 Ceramic artifact SA05-02 (left, above) discovered partly embedded in the sand as photographed without flash. (left, below) An underwater view photograph with flash clearly shows the curved base of the ceramic object.

Similar to SA05-01, the transition of the lower body to the base shows that the original vessel was *likely* shaped on a wheel, and is therefore unlikely to be prehistoric. Its exterior has been worn to expose inner layers, possibly by sand and current. While unlikely to be prehistoric, this item could be from the Classical age. It is also possible that it is older, and more analysis provide more information. Positive identification will be a challenge because of its size, and lack of associated artifacts as a surface find. The greater significance of the undated ceramic material to the survey is discussed later.

### SA05-03

SA05-03 measures 12cm by 10cm. The dark brown curved ceramic sherd fits the characteristics of shape and type for middle age (1400-1700 A.D.) common cookware found in Istria (Cunja 2004). The piece, discovered on the southwest side of Punta Piran, would have been one, of probably two, handles of cookware. The lip of the vessel shows the shape of curve, indicating size, and attachment of the handle to the body of the pot. Cut-marks are present on the inside of the top of the handle. This darker brown color of ceramic differs significantly from the color of other surface finds from this location. Additionally, the ceramic has white speckled inclusions and a hole approximately 2cm diameter. This find was discovered, on the surface, partially protruding from the sandy bank, at a depth of 9m.

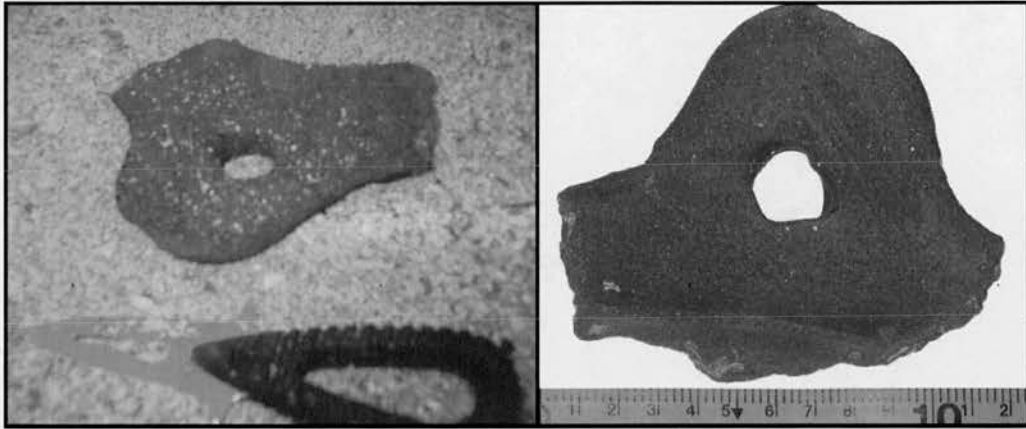


Figure 5.32 Ceramic artifact SA05-03.

#### **Lithic artifact: SA05-04**

SA05-04 is a lithic artifact recovered just to the north of Punta Piran.<sup>120</sup> The artifact exhibits bifacial retouch and opposed, bilateral notches at the proximal/basal end (fig 5.33). This could also be described to as a 'notched tang'. The notches may have been worn by hafting, indicated by smooth wear or polish on the inside of the notches. The material, later identified as chert, is medium-light brown in color, 4cm long and 2cm wide. Some darker reddish-brown markings are visible near the notched hafting-point on one side. This appears to be from oxidized material discoloring the surface of the chert. The very tip of the piece may have been broken. Although the piece was found under water, there are no signs of water rolling or abrasion caused by prolonged contact with sediment; the edges and ridges between flake scars are sharp.

Low power microscopic examination of the piece was conducted by Tomaž Verbič.<sup>121</sup> The chert appears to have no inner sedimentary textures. At 20x

<sup>120</sup> The find was originally discovered during a survey dive by Sergeant Jernej Celestina of the Slovene Navy. Sergeant Celestina assisted the 2005 survey season on a number of occasions (see appendix). The location of the find, at the perimeter of the Piran marine reserve will be discussed in further detail.

<sup>121</sup> Mag. Tomaž Verbič is a geology & geophysics advisor: Katedra za regionalno in sedimentno geologijo (University of Ljubljana).

magnification the surface of the material has a visible granular structure, the individual grains measuring c.0.05 mm. In spite of its granular character, the material has retained its massive characteristics, has no preferential planes, but contains no shell diffraction. The granularity appears to be diagenetic in formation. No *spongiosum radiolaria* or *spicula* are visible. The brownish freckly pigmentation is probably the result of iron oxides present as impurities in the material.

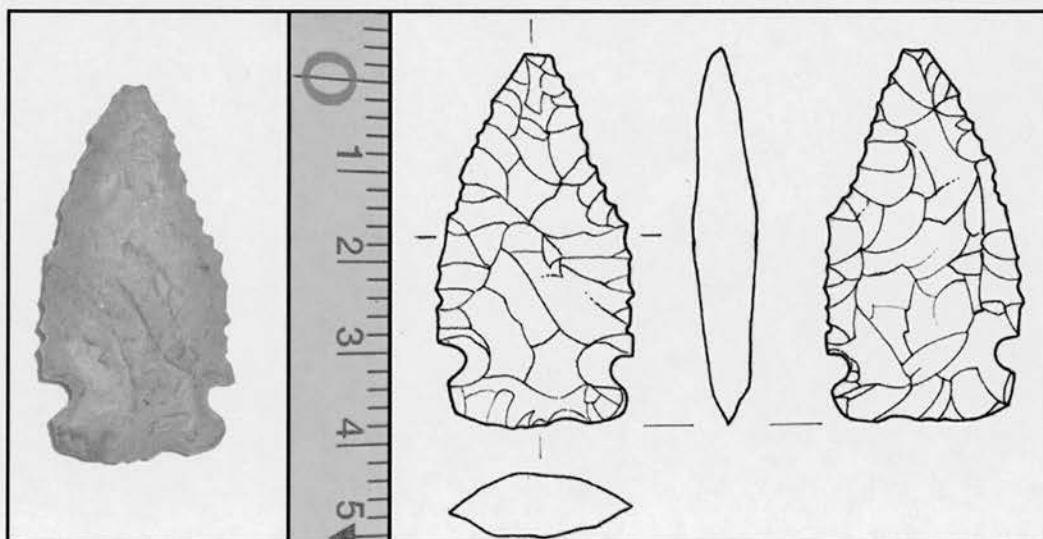


Figure 5.33 Photograph and sketch of SA05-04 a chert point (scale in cm).

On the basis of macroscopic examination of the material, the precise origin of the material cannot be determined, yet limestone formations with this type of chert are not found in Slovenia or in Istria. The most likely source is the Adige, in the Italian Alps. Silex bands from the Val di Non (Della Casa 2005, fig. 2b) appear similar in color to the Piran find, and other artifacts made from Adige chert have been recorded in prehistoric contexts in the Caput Adriae region (Boschian & Montagnari-Kokelj 2000).

The Piran find has no convincing typological parallels in this region, or further afield in Europe, before the final stages of the Neolithic. Projectile points with notched tangs have been recorded from Eneolithic (Chalcolithic) contexts at Monte Aiona,

Prato Mollo, and Val Frascarese in Liguria (Maggi 1984, 1987). However, the general form of the points from these sites is not consistent with that of SA05-04.

Morphologically, the closest parallels are not among projectile points, but among Late Neolithic and Chalcolithic knives and daggers found in Liguria (Bagolini 1984) and the Alpine region (Tillmann 2002; Schlichtherle 2003). While the typologically similar dagger found at a Chalcolithic site in Liguria is much larger in size (fig. 5.34), Late Neolithic daggers from southern Germany are significantly smaller, and similar in size to the chert point from Piran (fig. 5.35). At the site of Pestenacker in Bavaria there is a very similar specimen with notched tangs (fig. 5.35d) dated indirectly by dendrochronology to c.3550 BC, made from northern Italian Silex (Tillmann 2002; Schlichtherle, pers. com.). Furthermore at Allensbach, Germany, there are 'little standing knives' or daggers, which are between 5 and 7cm long (Schlichtherle 2003, fig 8, 3.4).

These knives show clear signs of reworking, and progressive reduction in size during the lifetime of the object (Schlichtherle 2003 and, pers. com.). Another extremely well known example from the region was found with the famous Neolithic 'Ice Man', known as 'Ötzi' (Egg *et al.* 1993); his dagger was almost certainly reworked, and exhibits secondary notches (Schlichtherle, pers. com.). Based on this established practice of reworking knives and diminishing size, it is likely that the knife found near Piran was reworked, as can be seen by pronounced flaking, creating steps in the edges (fig. 5.36). It is likely that the original size of the blade was between 5 and 8cm, which would appear to be a common size for the 'little standing knives' from the Late Neolithic in the central Alpine region (Schlichtherle 2003).

While widely agreed that sea level rise would have submerged sites of prehistoric human activity the small knife found north of the point of Piran does not represent a submerged site. The object typologically associated with the Late Neolithic was not discovered in situ. This is based on sea level rise data (Fairbanks 1989; Lambeck *et al.* 2004), and the depth of its discovery at 26m below sea level, which would not have existed as land during the time represented by this find: sea levels would have



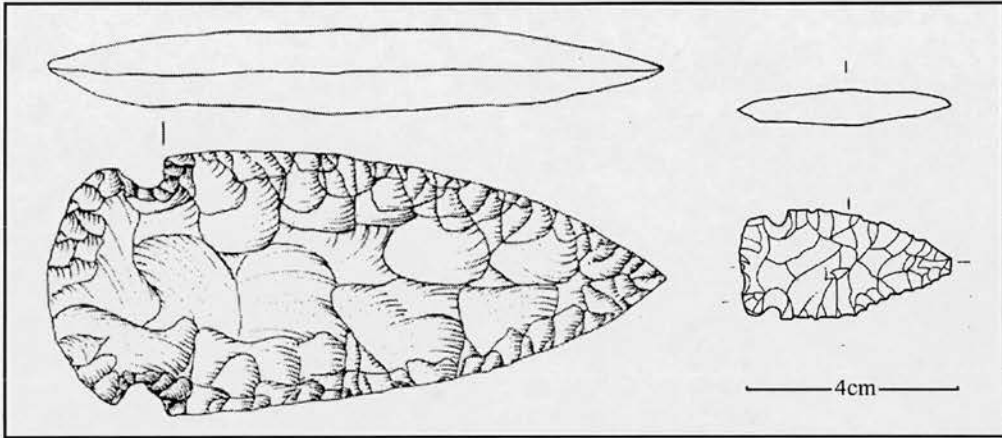


Figure 5.34 (left) A silex knife blade with a notched tang from the Chalcolithic of Liguria, is just under 12cm (after Bagolini 1984) shown relative to the notched point from Piran (right).

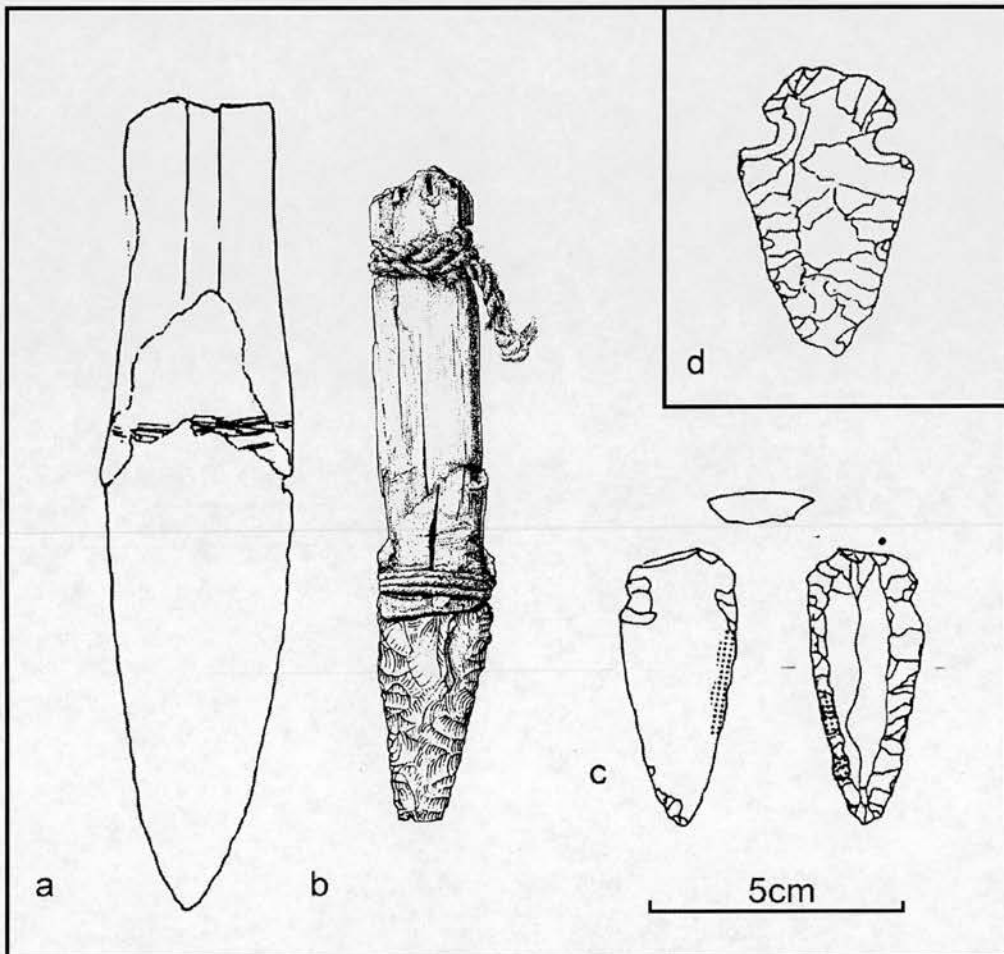


Figure 5.35 Late Neolithic knives/daggers from the Alpine region a) a hafted silex dagger from lake Constance (Schlichtherle 2003) b) the dagger found on 'Ötzie', 13cm with wooden handle (Egg *et al.* 1991; Barfield 1994) c) a 5cm dagger with subtle notches present (Schlichtherle 2003) d) a notched dagger from southern Germany which had northern Italian origins c.3500 BC, without scale (Schlichtherle 2003; Tillmann 2002).

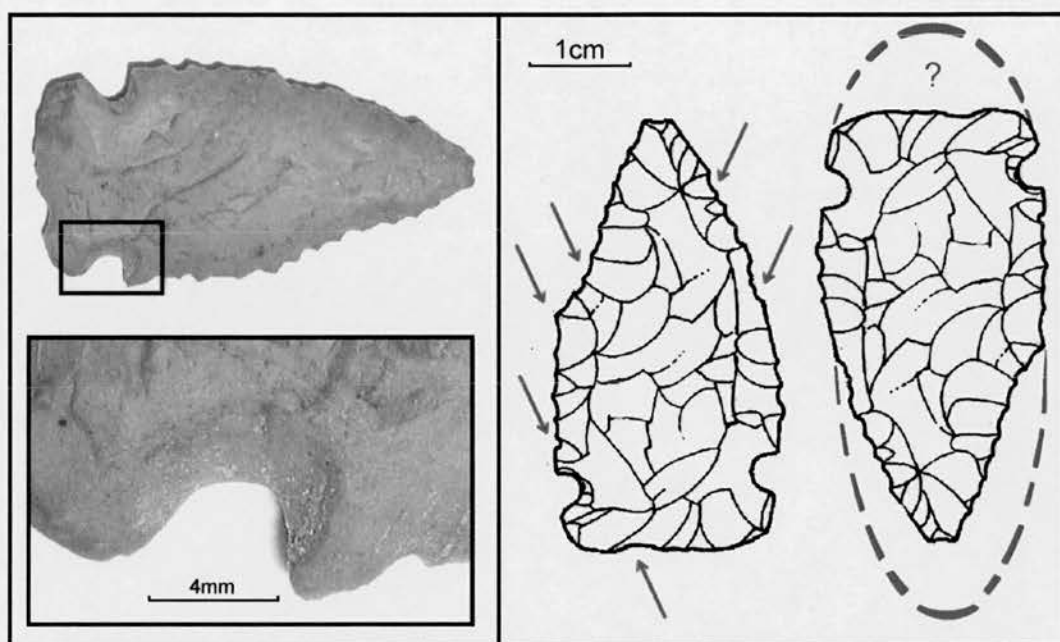


Figure 5.36 (left) A photograph of the notched tang shows a polished surface where white grain inclusions are visible. The polishing is probably the result of ware from hafting. (right) arrows point to areas of re-working. This process of removing material indicates that this tool would have originally been larger. A suggested reconstruction of the knife's size is thus presented. An estimated length of 5 – 8 cm is inferred.

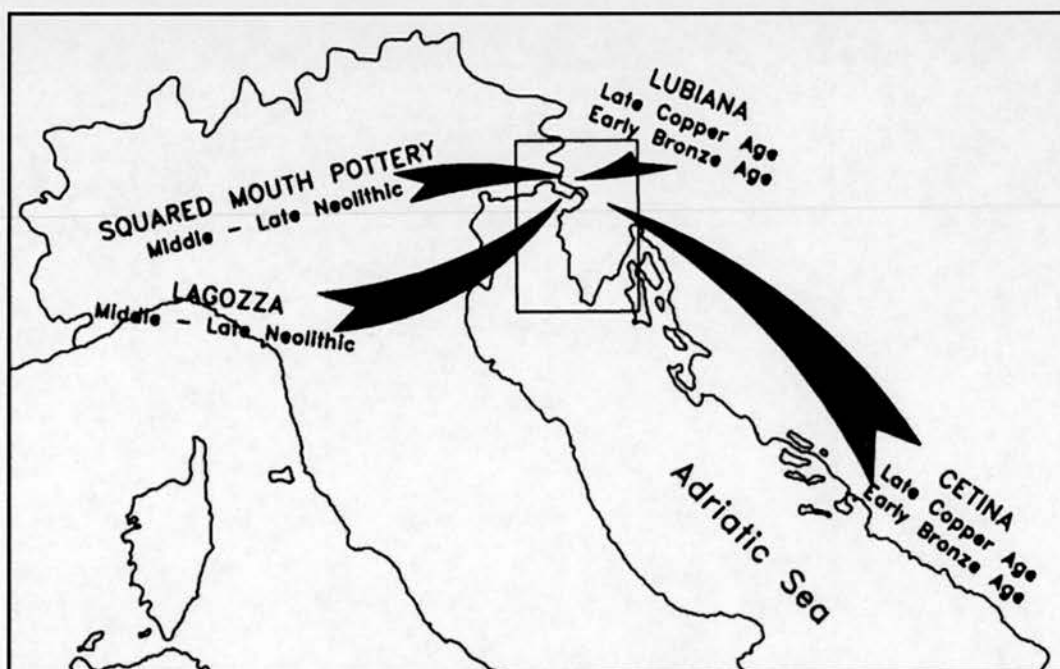


Figure 5.37 Neolithic cultural migration patterns (after Boschian & Montagnari-Kokelj 2000) show that the *Caput Adriae* saw migrating material culture from Liguria and the Italian Alpine region during the Middle and Late Neolithic. This is consistent with the Late Neolithic age typologically assigned to chert artifact SA05-04.

been only marginally lower than those of present day, no more than perhaps 5m at a maximum. Furthermore, the presence of a single find from the late Neolithic does indicate prehistoric activity in the region, though it does not confirm the existence of a greater archaeological site. Given the previously limited material discovered from the Neolithic of the Slovenian coast, this surface find can be considered a significant indication of Stone Age activity in the vicinity, and may indicate that future fieldwork near Piran is merited.

#### **5.4 Discussion: Practice, Results and Implications**

In order to focus on the problems of archaeology when conducting original fieldwork, all other obstacles must first be resolved. Logistics, equipment, local knowledge, contributions from other fields, and adequate preparation are all important. Many logistical issues were not possible to address and resolve prior to the fieldwork itself, however some of the preparations for the 2005 survey could have been managed differently. The elements of inadequate preparation are discussed herein, and important to future planning of similar underwater survey projects, or continued work in the Slovenian Adriatic.

##### **Sedimentation**

The sediments of the Slovenian Adriatic Sea, a result of erosion of the coastal flysch, produced the single most difficult element with which to work. This was most evident near the modern coast, especially in the bays of Koper and Piran. While original project ideas involved the Gulf of Trieste, including the northern side, in Italian territory, it was decided early that such environment was too difficult due to the obvious influence of river systems and the large lagoons in northeast Italy. Because of these obvious features, the Slovene coastline with only three small rivers, and no lagoons, appeared on the surface to be a much better area for such survey.

While the lagoons and deltas of northeast Italy may indeed produce difficult elements in which to conduct underwater archaeology, the less obvious problems of Slovenia were underestimated. Despite their relatively small size, the Dragonja, and Rižana, produce a significant amount of sediment, which rendered survey within the bays mostly impossible. Despite this, there is available data published on the sedimentation of the Slovenian Adriatic (e.g. Ogorelec *et al.* 1991), and there remained resources and knowledge that were not inaccessible prior to the fieldwork season outside of Slovenia.

### **The application of nautical charts**

The accuracy and resolution of nautical charts were important variables in regards to the plotting of the initial presupposition points based on the Danish model. While in Denmark, some initial presupposition points were plotted on a chart (scale 1:70,000), though it is the author's conclusion that a scale of 1:25,000 is a better minimum standard for the application of this technique.<sup>122</sup> This is especially true when accuracy of nautical charts and familiarity of the region are limited. The members of any local maritime community are more familiar with the intricacies of their own coastline; and a team of international archaeologists, regardless of theoretical technique and survey strategy, are less experienced with important practical elements.

While these considerations are part of the 'regional familiarity' phase of the project planning, there can be no amount of theoretical discussion makes up for practical local knowledge. This must also be weighed in regard to financial reality. It was not possible to hire a full-time local crew member which can be considered a financial consideration. Therefore, a failure to achieve such ideal conditions can be equated to a lack of funding. Additionally, local knowledge was indeed opportunistically utilized during the course of the survey and by the middle of the first month, several local divers and archaeologists had become involved in some form.

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<sup>122</sup> Fischer has recently updated his original baseline for the scale of nautical charts, and cites a scale of 1:40,000 as a minimum standard for the application of this survey model abroad (Fischer 2006).



While the feasibility study was successful in producing a result for the most feasible area for submerged prehistory, a lack of large quantities of prehistoric finds marks the study as a moderately successful result. Had abundant, high-quality finds been produced, such as those from the Danish Småland Bight (Fischer, 1993, 1995), the survey could have been considered an overwhelming success. Additionally, no paleosols or cultural landscapes were discovered despite the aim of finding early Holocene landscapes submerged by sea level rise. This is acknowledged as an extremely improbable suggestion, since no evidence of prehistoric finds had ever been reported by the local maritime community in any context. Along with an application of a new survey strategy within the region, expectations cannot be measured proportionally to those of southern Scandinavia.

## **Methodology**

While there were hurdles to overcome, as well as elements, which could have been conducted, studied or more carefully considered, the survey did produce measurable results. Establishing the methodology for original fieldwork is important to ensure a survey reaches its potential and is carried out successfully, accurately, and in line with archaeological practice. Since this research model was attempted for the first time outside of northern Europe, the methodology for this study was not clearly defined from the beginning. Tests and adaptations were required until the survey methods were satisfactory. During the early stages of the survey, staff adjusted to working together. Changes and refinements were made for both linear and circular survey techniques. Issues did arise, but were resolved quickly and the team was operating smoothly by the end of the first week. Thus, methodology became less of a struggle and full attention could be placed on the archaeological project goals.

## **Survey personnel**

A small team of four surveyors was required and the quality of the staff was extremely important. The June staff was chosen deliberately for its strong diving

skills and experience in underwater archaeological theory. This first group of surveyors was brought in specifically to establish methodology, and in particular, diving strategy. The secondary goal was to refine survey areas to those of highest potential. The success of the first month's team allowed for the July team to focus more carefully on these higher potential areas, particularly Punta Piran.

The involvement of locals and resulting education in underwater archaeology was a goal of the project, which was realized. The presence of the project team, based in Bernardin harbor, led to involvement and interest from off-duty navy and local sport divers. Visits with members of the local academic community served to intrigue university students and museum staff and emphasize underwater archaeological methodology and for prehistoric discovery in Slovenia and the eastern Adriatic. The survey team and project also gained positive recognition from some of the interested members of the local maritime communities of Piran and Portorož. Additionally, academics from Ljubljana became interested, and in one case a non-diving member of staff from the University of Ljubljana's department of archaeology took enough interest to certify as a diver, and participated in the survey.<sup>123</sup> It was frequently the case that non-archaeologists who became interested in the project had never heard of underwater archaeology. Even more frequently was the surprise with the team's response to what age of material was sought using the survey model. The result of increased local awareness and education is difficult to measure quantitatively; however, the community involvement and archaeological finds now housed in the maritime museum in Piran are a positive contribution to underwater archaeology and the study of submerged prehistory in Slovenia, and the greater eastern Adriatic coastal zone.

A small team has both its strengths and weaknesses. In the case of this survey, the absolute minimum number of people, four, was required for a rotating schedule of two divers up, two down. The lack of additional, or 'back-up' staff, can be a concern, given fieldwork schedules. Should one member of the team have a physical

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<sup>123</sup> Matija Čresnar, Assistant, Ljubljana University, Department of Archaeology.

problem which prohibits him or her from taking part in the day's diving the survey schedule could be at risk if a substitute is not found. Fatigue can impact a small team, both in the form of physical and mental ability; physical conditioning and personalities can directly affect a project's success. When available extra personnel can be beneficial and on more than one occasion, local divers, trained and educated for the purpose of the survey, were used to fill a void of a team member who was unable to dive.<sup>124</sup>

### **Archaeological material**

While the initial interest in underwater archaeology in Slovenia developed from a prehistoric perspective, maritime finds were treated as submerged cultural heritage, and recorded appropriately. Finds, such as the stone circle from near Point Strunjan, are not the results of a specific search for maritime cultural history, but rather the result of general archaeological survey. A diving survey intended for prehistoric discovery may be compared to a land survey of the same nature. A field-walk, whereby research interest is intent on discovering evidence of early farming activities, but instead produces a Roman camp can be considered a parallel example. While a prehistoric approach may not focus on classical periods of antiquity, standard archaeological practice dictates that documentation of any such material is practiced regardless of interest or intent.<sup>125</sup> The same is true with regard to an 'underwater field-walk', wherein a surveyor, diving or snorkeling, while seeking the discovery of small artifacts such as flint tools finds a maritime feature. Proper archaeological documentation must be practiced, and an excavation should not be carried out by a survey team unprepared for such an undertaking. These principles were practiced during the 2005 survey. The finding of maritime features and artifacts can also help strengthen a project's merit to the local community. This is particularly true for maritime historians and museums, which can benefit from

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<sup>124</sup> See appendix for complete set of individual dive logs.

<sup>125</sup> The reverse is also true as has been seen from Mesolithic sites discovered by surveyors seeking much younger finds (e.g. Brusić 1977; Lübke 2002; Gaspari 2006).

such new finds, and who may act to establish, or solidify collaborations with local institutions.

While it is established that there were important variables underestimated in the theoretical planning of the survey, each adversity overcome can be regarded as a positive and successful adaptation of the Danish model to the Slovenian Adriatic. Defining the location of highest potential for prehistoric human activity was a primary goal to the survey, and eventually accomplished. Sediments, which were troublesome, but eventually predictable, were overcome by searching first in the central gulf, and later along the headlands away from the river valleys. Currents were observed in each dive location, noted within the environments of locations surveyed, and considered as important variables particularly for site recognition.

The discovery of ceramic finds, some of which can be typologically dated, is a successful result of the survey. All surfaced finds were donated to the museum in Piran as regional material cultural. Ceramics, such as the dark cookware handle typologically dated to 13<sup>th</sup> – 17<sup>th</sup> C. AD., provide important information about the *feasibility* of prehistoric site discovery near Piran. Since this ceramic handle is between an estimated 400 - 700 years old, that the discovery of such an artifact, partially covered by the seabed, in this case composed mainly of sand, is telling. The case is strong that since an artifact of this age has not been covered by sediments, nor has it been removed by currents, the conditions near Piran suggest that the potential exists for the discovery of ancient material. Prehistoric material is likely to be only centimeters below the sand, rather than under meters of Holocene sediment; conditions which exist in the inner bays of Koper and Piran. These favorable conditions can be related to cores taken in the central gulf (Ogrinc 2005), and suggests the need for further environmental sampling near Piran.

The chert artifact, typologically defined with the late Neolithic, provides an interesting piece of evidence for prehistoric activity on the coast of Slovenia. While it may seem logical to assume that Piran was inhabited during prehistoric times, there has been no direct evidence from Piran to support such a claim. Additionally,



the knife found near Piran, is the oldest artifact to have been discovered underwater in the Slovenian Adriatic sea, three millennia older than the previous oldest find: a 1<sup>st</sup> Century B.C. Roman amphora, currently housed in the Piran Maritime Museum collection (Karinja, pers. com.).<sup>126</sup>

Piran fits the environmental criteria described by the Danish Model; with acceptable currents, sediments and topographic/bathymetric contour. Its situation at the headland and tip of a bay approximately 5km across is also favorable according to the model. Additionally the presence of datable historical material, additional ceramics, and a single flint tool which can be typologically datable to approximately 3500 BC, based on comparisons with the daggers from Pestenaker (Tillmann 2002; Schlichtherle 2003) can be seen as compelling evidence that a more comprehensive underwater archaeological investigation may be appropriate at Punta Piran.

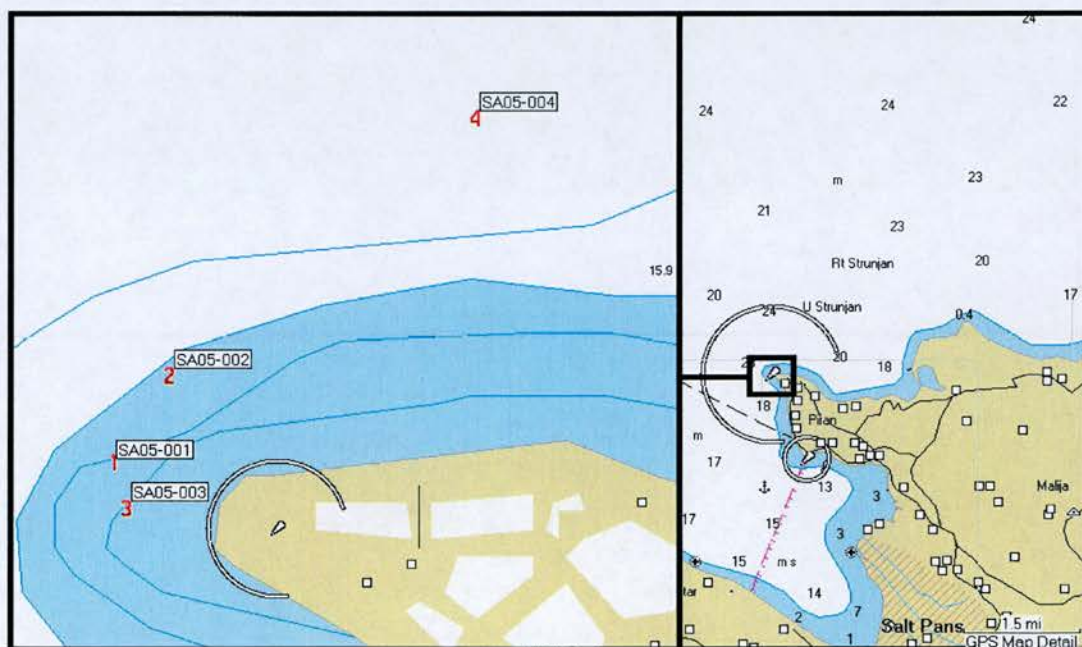


Figure 5.38 Surfaced finds and their locations from Punta Piran show that this area is favorable for archaeological discovery. Piran is therefore the primary location for future underwater work based on the results of the 2005 underwater survey season.

<sup>126</sup> Snježana Karinja, Archaeological curator, Piran Maritime Museum (*Muzej Sergej Mašera*).

## 5.5 Reconsidering Sea Level Rise and the Slovenian Adriatic

The primary inspiration for the underwater archaeological survey of the Gulf of Trieste was the potential for Mesolithic and early Neolithic archaeological site discovery. As previously shown, there is a notable absence of prehistoric sites on the Slovenian coast. There have been several paleoenvironmental reconstructions suggesting that such sites would now be submerged (e.g. fig. 5.1, 5.39) and archaeologists have relied on these environmental reconstructions in the discussion of regional site distributions (Budja 1996, fig. 5, 6).<sup>127</sup> Such reconstructions have been used to suggest paleocoastlines in the middle of the Gulf as late as 6700 years ago. Therefore, based on sea level rise data, it has been assumed that the Gulf of Trieste may contain some of the earliest Neolithic sites in the *Caput Adriae* (Biagi *et al.* 1993; Budja 1996; Boschian & Montagnari-Kokelj 2000). Based on available data (Ogorelec *et al.* 1991, 1997; Ogrinc *et al.* 2005) and observations from the 2005 survey, much of the area of the Slovenian coastline, previously thought to have been inhabitable for early Neolithic groups, appears to have been submerged long before the Neolithic.

While previous reconstructions have been used to imply a Neolithic coastline far from the current coast, there are regional variables, which cannot be ignored. After observing sedimentation of the inner Bays of Piran and Koper, as well as the smaller bays of Fiesa and Portorož, it is clear that Holocene sediments have impacted not only the potential for archaeological discovery, but must be considered in the calculation of the paleoenvironment of the Gulf of Trieste. The nearshore sediments off the Slovenian coast are significant (Ogorelec *et al.* 1991, 1997) and recent analysis of the sedimentation and radiocarbon determinations of peat horizons from the Gulf (Ogrinc *et al.* 2005) indicate that transgression took place in the inner bays of the Slovenian coast between 8000 and 7000 BC (fig. 5.40).

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<sup>127</sup> Budja (1996, fig. 5, 6) cites Šegota & Filipčič (1991) for the original reconstruction of paleocoastlines in the Gulf of Trieste. This reconstruction uses the modern 20m bathymetric contour as the suggested ancient coastline between 7950 – 6750 BP.

The assumption has been to consider sea level rise along with modern bathymetric measurements, and base reconstructions on these factors, (e.g. Shackleton *et al.* 1982; van Andel *et al.* 1989; Budja 1996). This method of reconstructing coastal zones is dangerous, and regional and local variables such as sedimentation must not be over looked (Pirazolli 1996). Recently, Mlekuž (2005b) has addressed this matter. Because of the Holocene sediments and the rapid deposition of flysch material, the modern seabeds are not indicative of the conditions of 10,000 years ago (Ogorelec *et al.* 1997) in many locations. Thus, while the sea level rise data produced by Fairbanks (1989) and Lambeck *et al.* (2004) is accurate, the seabed of the Gulf of Trieste has changed significantly. The muddy bottom that currently exists throughout much of the Slovenian territorial sea would not have existed in the early Holocene, and so these submerged valleys would have been significantly deeper. This would have allowed for the transgression to flood these valleys much earlier than previously assumed, as the rising seas would have reached the levels of between 25m depth by 7000 BC (Lambeck *et al.* 2004, fig. 4). Hence the previously designated 'Neolithic coastline', said to have existed until c.6700 BP (Budja 1996), is grossly inaccurate for much of the Slovenian coast.<sup>128</sup> This is confirmed by data suggesting that the original seabed now lies under several meters of Holocene sediments (Ogorelec 1997; Ogrinc 2005).

The impact of sea level rise and recent geomorphological considerations on the potential for submerged archaeological sites in Slovenia must not be overlooked. This does not imply however that Neolithic material will not be discovered underwater. Conditions on the perimeters of the sedimentation zones, most notably, the conditions at Punta Piran, do allow for the submergence of Neolithic aged material during the transgression. Given the light sedimentation, particularly on the northern side of Piran (fig. 5.26), it is still possible that the late Mesolithic and early Neolithic landscape existing from 6500 to 5000 BC may be submerged under 10m –

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<sup>128</sup> This would not impact the sea level rise data posed by Italian scientists (e.g. Morocco *et al.* 1991) since sedimentological conditions of Italian waters are far different from those found on the flysch coasts of Slovenia. Thus this phenomenon is locally isolated to the Slovenian coast, while the Italian data appears to be accurate.



20m of water (Lambeck *et al.* 2004, fig 4).<sup>129</sup> Furthermore, results of the 2005 survey indicate that individual finds can be recovered through underwater archaeological survey, particularly when the surveyor is focused on finding smaller, less obvious material. Finally, Neolithic installations, such as fishing structures or features of ancient maritime transportation may also be found in submerged environments where sedimentation has not buried the relevant archaeological material (Fischer 2006). As suggested, Mesolithic sites also exist in submerged conditions, both in modern coastal margins as well as in the submerged Adriatic Plain. While finding Mesolithic sites underwater in Slovenia is a considerable challenge, it cannot be argued that the material does not exist in the submerged environment of the Gulf of Trieste.

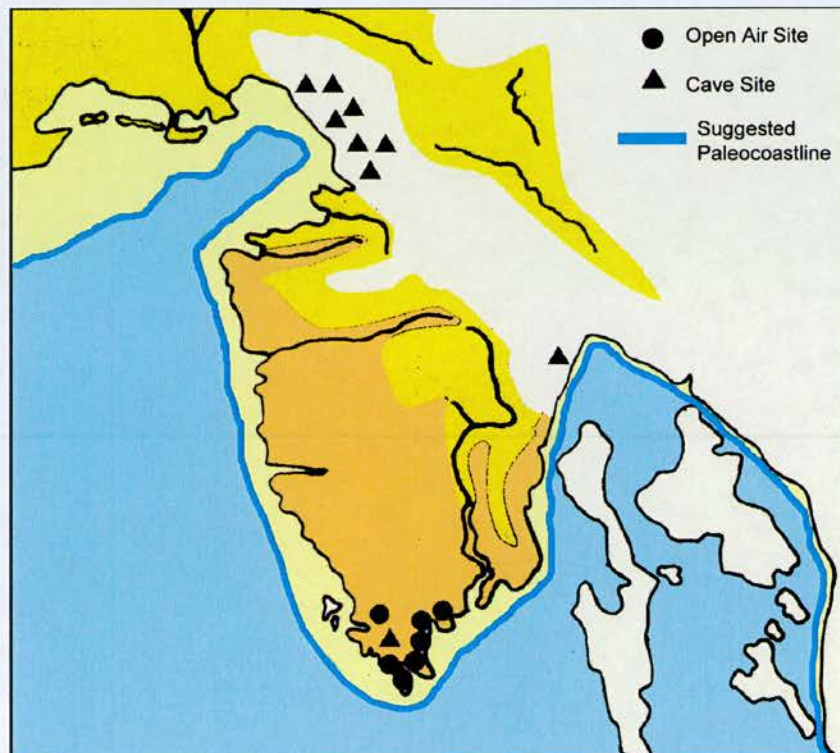


Figure 5.39 Early Neolithic site distribution in Istria and “Adriatic Sea level in the period 7950 – 6750 BP” (Budja 1996, 67-68). This reconstruction of sea level during the early Neolithic is incorrect.

<sup>129</sup> This is based on the favorable sedimentological considerations observed at Piran during the 2005 survey, and an assumption that sedimentation is not significant greater than a few meters of Holocene sediments. This speculation, however, must be confirmed by core sampling, which has not yet been conducted at Punta Piran.



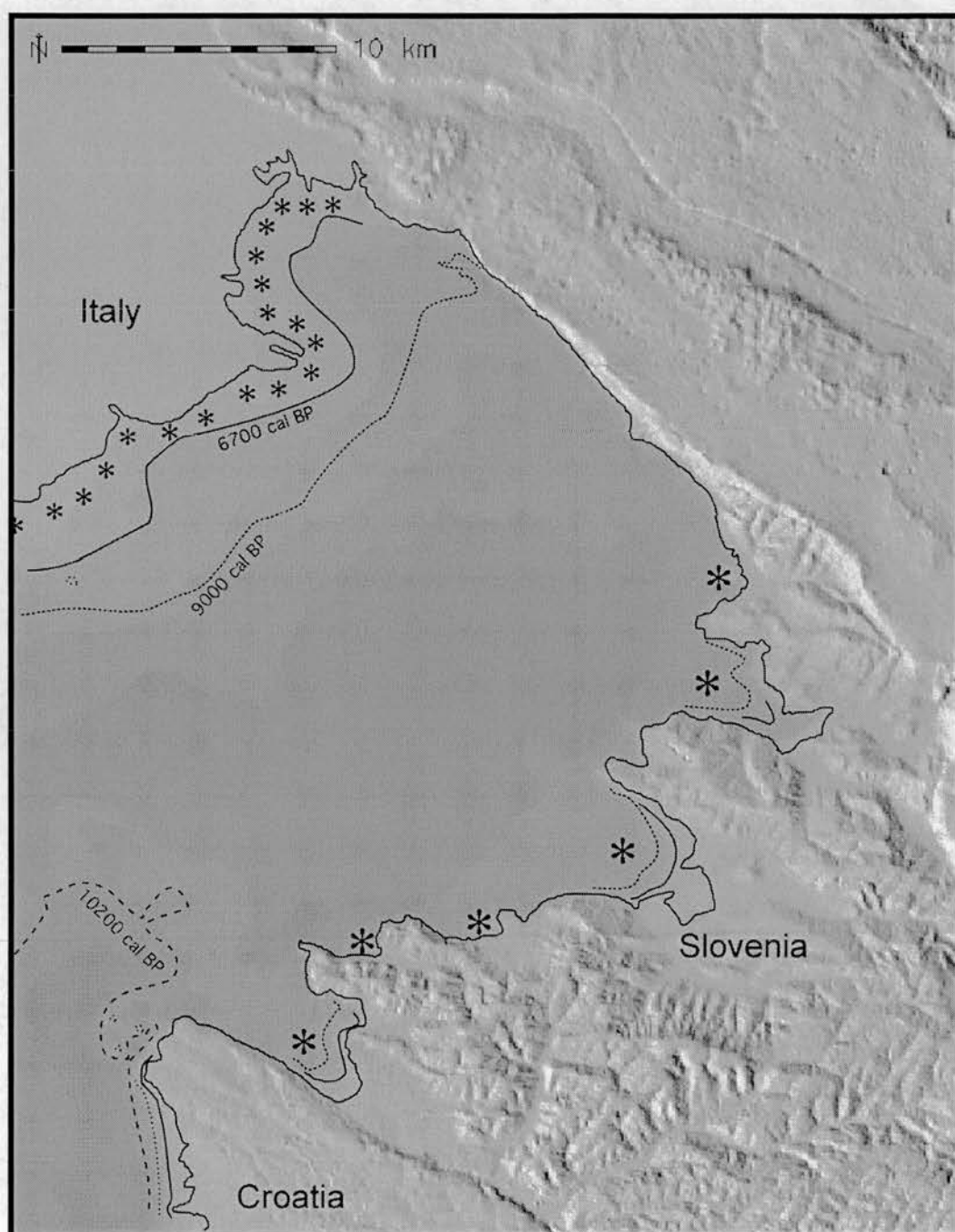


Figure 5.40 A reconstruction of the paleocoastlines of the Gulf of Trieste by Mlekuž (2005) has considered sedimentation and original seabed depth. This is significantly different from those of the previous decades.

## Chapter 6

### A Reevaluation of the Applied Survey Model and a Proposed Future Strategy for Underwater Archaeological Site Discovery in the Eastern Adriatic

### 6.1 Discussion: Implementation of the Underwater Survey Model

One of the principle goals of the 2005 survey of the Slovenian Adriatic was to adapt and apply the southern Scandinavian model to a southern European environment; the first such feasibility test of the survey model. The regional and local variables of the northeast Adriatic Sea and surrounding coastal landscapes are unique in their archaeological potential: a notion considered since the conception of the project. Future fieldwork with similar aims must be conducted before this model can be applied with consistent results throughout southern Europe.

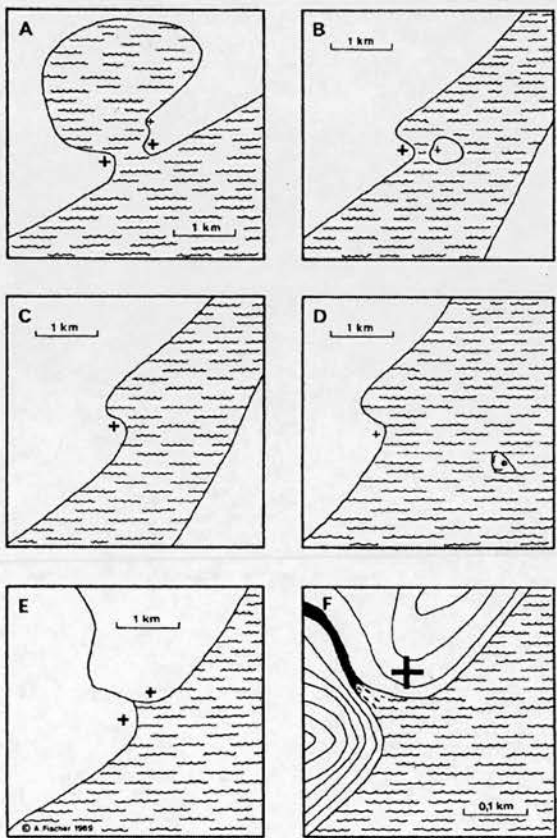


Figure 6.1 Topographic locations of Mesolithic-Neolithic coastal settlements based on the southern Scandinavian model (after Fischer 1995). A) Narrow inlets connecting large bodies of water. B) Between a small island and mainland. C & D) at the tip of a headland. E & F) at the mouth of a stream. These generalized locations along with regional and local variables can be considered and applied to survey in the eastern Adriatic.

Several theoretical presupposition points were abandoned as a result of local conditions of sedimentation. Nevertheless, Punta Piran has emerged as the location of highest potential for submerged prehistoric human activity. In this respect, the Scandinavian survey model has been applied in southern Europe with modest initial success. Punta Piran meets the geographical requirements put forth. The presence of

archaeological material (described in the previous chapter), and environmental variables adjusted to the coastal Slovenian parameters, illustrate that Piran is a suitable location for survey according to the model. Despite a lack of large scale surface scatters of Stone Age material, there may exist material underneath the surface of the seabed, as was discovered at Aghios Petros (Flemming 1983). Future study will continue to advance the survey model, as methodology will be refined to increase the potential of underwater archaeological discovery of submerged prehistoric sites.

### **6.1.1 Reevaluating the predictive survey model for international practice**

While practical survey methods have been established (Fischer 1993), there are important elements of this model, which are missing. If the three-phase survey strategy is to be applied internationally, as suggested by Fischer (1993, 2006),<sup>130</sup> the model must be adjusted. An amendment of one phase and the addition of two further phases are suggested.

A revised model for the survey of submerged Mesolithic-Neolithic sites:

Phase I – Familiarization of regional archaeology

Phase II – Map/Chart plotting

Phase III – Geological and geomorphological consideration

Phase IV – Localization and delimitation for sites by echo-sounder

Phase V – Mark the theoretical site with a buoy, and dive to investigate

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<sup>130</sup> It should be noted that inspired by communication with the author, Fischer has included a section entitled *Similar potential abroad?* in his most current publication discussing “*Coastal Fishing in Stone Age Denmark*” (Fischer 2006, *in press*). Based on discussions with the author and reconsiderations, Fischer has concluded that a scale of 1:40, 000 (or more detailed) nautical chart should be employed, and has added a statement for the need of archaeological surveyors with “some degree of archaeological field experience.” (pg. 3). Nevertheless, the discussion for Fischer’s model abroad found herein can be considered more comprehensive, as it is based on experience in the Adriatic, as well as personal communication with Dr. Fischer.



Phase I (Familiarization of regional archaeology) was originally omitted because of its obvious nature, however it should be stated: the archaeological team must be or become familiar with the regional material culture and prehistoric settlement patterns. Familiarity with settlement distributions, and the type of economy the prehistoric groups practiced, assist in predicting prehistoric site locations. This can be achieved by studying areas which have not been submerged, or locations which have since undergone isostatic uplift (Fischer 1993; Bonsall 1996). Researching the published archaeological record and utilizing local knowledge are the first steps to establishing how and where to plot locations for presumed prehistoric activity.

The required familiarity with local material culture is crucial due to the nature of underwater survey. The lack of available underwater communication,<sup>131</sup> along with time constraints, limited air supply, and physiological constraint of breathing compressed gasses, confirm the need for surveyors to be able to effectively and independently identify archaeological material (Muckelroy 1978). This familiarization process was originally undefined since the underwater surveyors in southern Scandinavia were familiar with local material culture (Fischer, pers. com.). However this is an important consideration, which must be addressed if the model is to be successful at an international level. Familiarity with the regional archaeology is especially important when a local underwater archaeological community does not exist or when an international team attempts to survey foreign territories. Fischer himself suggests that there were foregone considerations for choosing specific locations within the Småland Bight because “it is an area with abundant raw materials and in all probability also abundant remains of an extensive Stone Age occupation” (Fischer 1993, 61). Regional familiarization must not be omitted in the definition of methodology for an international application of the presupposition model.

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<sup>131</sup> There are methods of communication underwater, which include both communication between divers, or communication with the surface, though these are generally expensive and not yet considered standard diving equipment. Nevertheless some underwater archaeological units regularly employed such underwater communication devices (e.g. Lübke, pers. com.). This is certainly the future of underwater archaeological fieldwork, given technological advances and the usefulness of underwater communication between divers.

Phase II (plotting survey locations) must be partially redefined. Maps and charts can vary greatly in accuracy, and therefore reliability. Since topographical positioning of sites relies on the reconstruction of the paleoenvironment, the maps used must be adequate if the chart is up to date and rich in bathymetric detail. A finer scale may be required if the data are insufficient. Additionally, seabed profiling may need to be conducted if ample bathymetric data are unavailable.

Phase III (Geological and geomorphological consideration) identifies the need to thoroughly investigate the geological and geomorphological impact on survey sites prior to diving. This is perhaps the most important element omitted from Fischer's initial model. As a result of years of practical experience with coastal morphology, the problematic areas were automatically and unconsciously omitted from Fischer's initial research in Denmark (Fischer, pers. com.). The consideration of such geophysical elements is extremely important, while local variables such as sedimentation must not be overlooked.

The identification of accessible cultural landscapes includes issues of erosion, sedimentation and changes in topography (Grøn 1995). In cases of extreme physical change such topographic models suggested by Fischer become less reliable. Furthermore, material from inflowing agricultural systems and industrial activities can have a devastating impact on submerged landscapes and underwater sites. Grøn advocates familiarization with regional geological surveys. In the best cases, hundreds of borehole data are available to archaeologists, as was the case at the Strynø Basin project.<sup>132</sup> It is thus suggested (in a new Phase III) that the regional marine geological data be studied with a focus on Holocene sedimentation. The conditions should be carefully evaluated while considering suggested presupposition points. Consideration of geological variables and site plotting (Phases II and III) may be done concurrently as a process.<sup>133</sup>

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<sup>132</sup> Grøn also cites examples of topographical areas generally more accessible, such as protected headlands, not subjected to such deposition. Møllegabet I & II, at Æro, are examples of such accessible locations (Grøn & Skaarup 1991).

<sup>133</sup> It is suggested that this process occurs over a period of time while research and information is conducted. Re-evaluating and updating survey locations should be expected during Phases II and III.

It is important to note, however, that sedimentation and ‘undesirable’ seabed composition do not necessarily imply that archaeological discovery is impossible. It is established that submerged Stone Age material has been discovered in a variety of seabed compositions and coastal environments (Flemming 1983). Furthermore, “Approximately 80% of the Danish sea bed is classified as mud and sand, which to the inexperienced underwater researcher may sound like a non-rewarding place to start surveying. Nearly all the rest of the Danish sea floor may appear equally unpromising...” (Fischer 2006, 3).<sup>134</sup> While geological assessment can be useful, it should be the sole consideration when planning underwater survey, localized areas may exist as exceptions to an otherwise unlikely region of study. This is demonstrated by the findings at Punta Piran during the 2005 survey of the Slovenian Adriatic.

## 6.2 Satellite Images, Nautical Charts and the Survey Model

Aerial and satellite imagery have been used to assist archaeological fieldwork in coastal zones (e.g. Cox 1992), thus the notion and the technology itself are not new. However, the *availability* of this technology is a new phenomenon. During the fieldwork planning phase, in 2004-2005 potential survey locations in Slovenia were plotted on the available nautical charts *without* the benefit of high-resolution, accessible satellite imagery. Since then, however, access to global satellite images has become readily available.<sup>135</sup>

The new availability of high-resolution satellite imagery will impact studies of submerged cultural landscapes, defining paleocoastlines, and surveying locations with potentially enormous results. Additionally, modern constructions, such as harbors, levees and other disturbances, both close to and in the water, can be

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<sup>134</sup> As Fischer 2006 is currently *in press* at the time of the writing of this dissertation, the page number here is referenced as originally submitted (in *word* document format) for publication by Dr. Fischer.

<sup>135</sup> Satellite images provided by Google Earth have been available since June 2005. Ironically, the service was launched while survey in Slovenia was already underway, and played no role in the survey itself. The impact of this increased access to global satellite images at a variety of resolution is already evident within the archaeological community.

identified using such imagery.<sup>136</sup> This is particularly useful when such human impact may not be indicated in detail on nautical charts or regional maps.<sup>137</sup> Additionally, the quality and the geological material of the landscape can be seen from above based on modern agriculture, forests, and barren terrain. When compared with bathymetric data from available nautical charts, and topographic maps, satellite imagery can be a valuable tool and used for the project planning of the eastern Adriatic. This is particularly relevant to the application of the survey model to the Croatian Adriatic.

### **6.3 Proposed Underwater Archaeological Investigations of the Eastern Adriatic**

Future study based on the experience and results of the Slovenian Adriatic survey can be applied toward future fieldwork in the eastern Adriatic. The conditions and archaeological material from Piran are perhaps a first step in the exploration of this headland; however the methods used may be further tested and refined to the region with potentially greater results. Proposed future fieldwork would begin most logically at Piran in the Slovenian Adriatic, pursuant to the 2005 survey results. However a preliminary discussion on theoretical future fieldwork will expand geographically to the Croatian Adriatic Sea. The principles of Fischer's model are applied; furthermore, regional factors that suggest the potential for archaeological site discovery along the eastern Adriatic are described herein.

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<sup>136</sup> Though the most recent constructions may not appear in satellite imagery, depending on the age of the photograph.

<sup>137</sup> One example of this, relevant to the Slovenian coastline, is the resort and harbor at Bernardin, which is not indicated on the nautical chart (scale 1:75,000) of the Gulf of Trieste.



### 6.3.1 Slovenia

The proposed next step regarding the underwater archaeology of the Slovenian Adriatic is to further investigate areas of interest as determined by the feasibility study conducted in 2005. For maritime archaeologists, an excavation of the stone feature near Strunjan may produce further evidence of local maritime activity.<sup>138</sup> Regarding prehistoric archaeology, Punta Piran is the logical place to continue to investigate the transgressed coastal prehistory of Slovenia.

Based on current data, Piran and the submerged landscape near the point have the highest probability of future underwater archaeological discovery on the Slovenian coast. Environmental sampling along the coast could yield potential dates of sea transgressions, coastal evolution at Piran, and add to the overall regional archaeological record. This should be conducted at a variety of depths, using coring techniques practical for a sandy sloping seabed. Additionally, once an age-to-depth ratio can be extrapolated from environmental data, such as that presented for the central gulf and inner bays (e.g. Ogorelec *et al.* 1991, 1997), test excavation would be possible. Test excavations could provide additional archaeological finds from prehistoric, classical, and historical periods. This is based on surveys from the 1950's, 1980's and 2005 (Bonton-Tome 1989; Knific 1991). Classical finds are likely present in this submerged environment given the amount of regional activity during Roman occupation of Istria and known Roman archaeology from the immediate vicinity. However, the late Neolithic knife discovered during the 2005 season, suggests it is also reasonable to expect that Stone Age material could be discovered during such test excavations.<sup>139</sup>

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<sup>138</sup> Initially, a cleaning of the sediments around the perimeter of the stone circle should define the actual size of the feature. Located in the nearshore waters at just 7m depth, logistics and safety would be much less complicated than a deep water archaeological project.

<sup>139</sup> Given sufficient time, equipment and personnel, multiple pits or trenches could be excavated. One benefit of conducting such test excavations is the nearshore location near the Point of Piran. This proximity to land means that some activities can be carried out on land, eliminating the need for all logistics managed on a boat. This is helpful in regard to heavy equipment, and the cost of hiring and operating a large vessel required for extensive excavation. This logistical consideration is important, particularly regarding safety and financial considerations.



Figure 6.2 An aerial photo of Punta Piran. The submerged environment near Piran is the most logical location for future study (photo by author).

### 6.3.2 Western Istria, Croatia

The north-western point of Istria, marked geographically by point Savudrija, is the beginning of a future potential area for underwater survey in the *Caput Adriae*. Locations of potential interest exist from Savudrija toward the towns of Umag and Novigrad. Here, geological conditions differ greatly from those found at the Slovenian coast. In western Istria, the mainly limestone landscape (which begins on the Croatian side of the *Dragonja* river valley) may provide a much more conducive environment for underwater site discovery. As a result of the favorable limestone composition, and lack of flysch, sediments measurements taken near the town of Poreč are a small fraction of those encountered in Slovenia (Ogorelec *et al.* 1991). Additionally, depth and bathymetric contours, shown on the nautical charts, indicate a presence of topographic features sought when employing Fischer's survey model (fig 6.1).

Due to legislative reasons, Croatia was not explored during the 2005 season, as permission for both archaeological survey and diving requires a much greater level of collaboration with local institutions than most European countries.<sup>140</sup> The survey of Croatian Istria has yet to be realized, but it would make for an interesting future study. Given the geological conditions of Croatian Istria, the prospect of prehistoric sites existing on the seabed and their possible identification during survey is greatly increased. Kovačić (2002) has discovered a variety of archaeological material in western Istria, but the difference in survey techniques, employed for such underwater artifacts as amphorae, compared to Stone Age material must be acknowledged (Fischer, pers. com.).

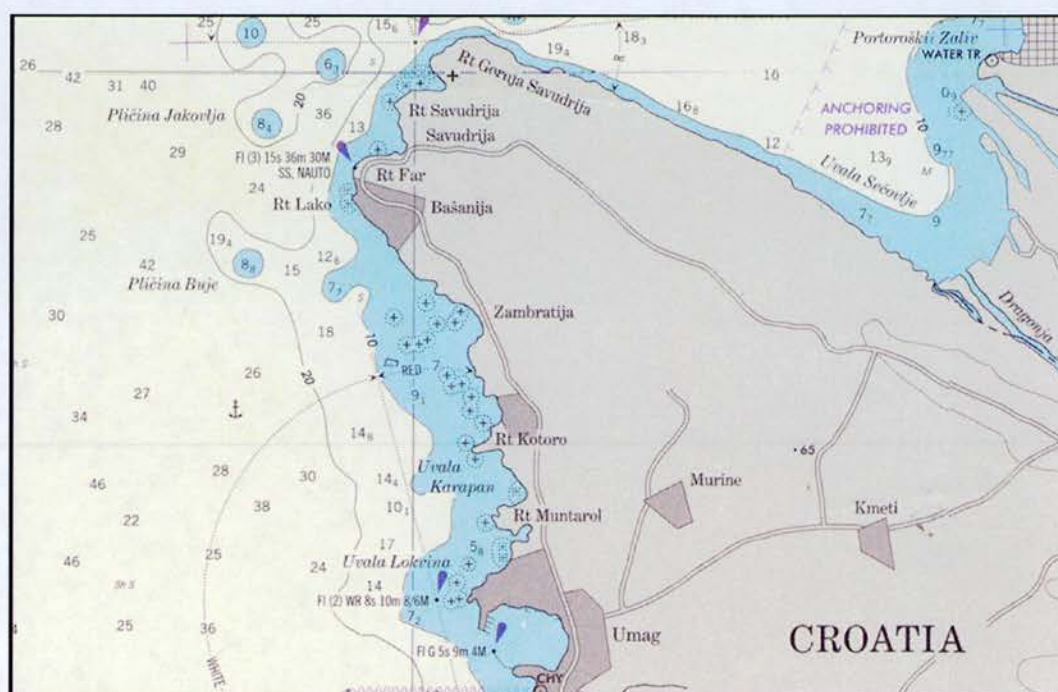


Figure 6.3 Nautical chart of northwestern Istria, between Umag and Savudrija (1:75,000 original scale).

<sup>140</sup> Permission to conduct underwater archaeological research in Croatia is granted only to a team lead by a Croatian national, and to a research team composed of at least 50% Croatian citizens. Additionally, a research vessel operating on Croatian waters must fly a Croatian flag (i.e. be registered in Croatia). This made diving and surveying in Croatian waters impossible for the 2005 season.



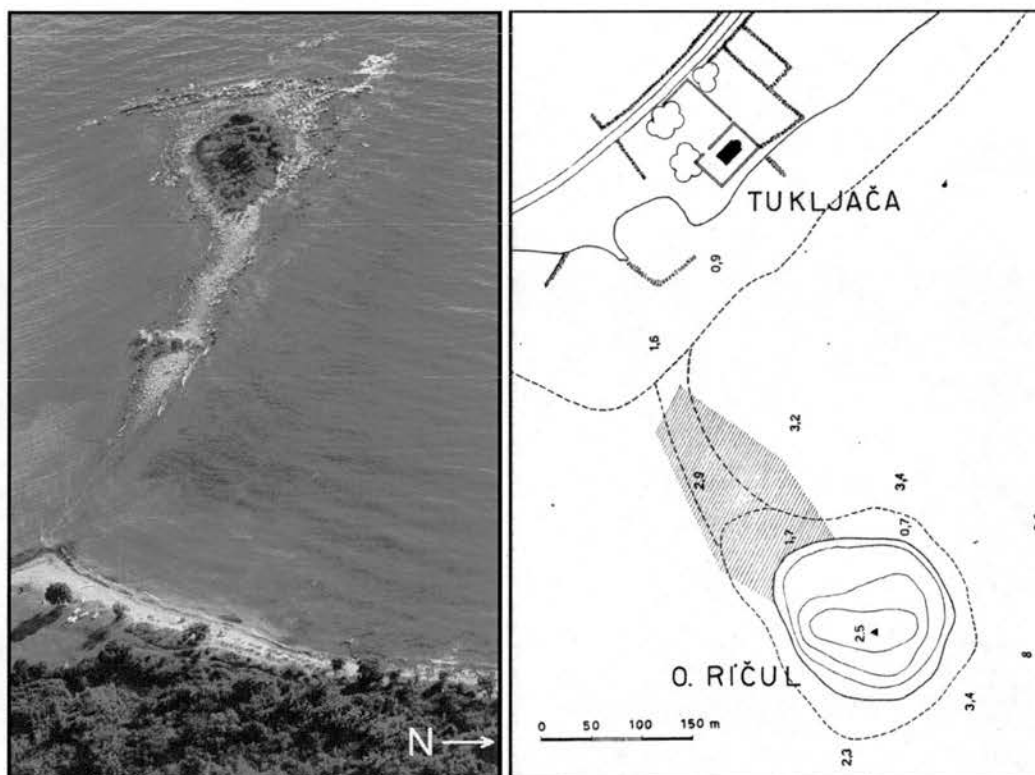


Figure 6.4 (left) An aerial photo of a foreshore islet found between Umag and Savudrija, northwest Istria (photo by author). (right) a similar 'Islet' feature from central Dalmatia, which yielded archaeological material from Stone Age to historic periods (after Brusić 1977).

This evidence presented by Kovačić indicates that archaeological discovery in western Istria and preservation of material at least two millennia in age can be achieved. The presence of more ancient material in this region has yet to be determined. According to Fischer's model for presupposition of Mesolithic sites in Scandinavia, areas of potential interest in northwestern Istria do exist. Confirmation by sonar and underwater survey is required here. Additionally, there is at least one feature between Umag and Savudrija similar in morphology and size to the 'islets' identified by Brusić (1977) at which prehistoric material was recovered in central Dalmatia (fig. 6.4).

### 6.3.3 Dalmatia

Western Croatia is plentiful in late Stone Age archaeological sites (Batović 1979; Chapman & Müller 1990; Forenbaher & Miracle 2005) and is likely the best region



in the greater Adriatic for an application of Fischer's survey model. Since the region was under constant change during the late Pleistocene and early Holocene (Chapter 3, fig 3.4), it is accepted that archaeological material would have been submerged by early Adriatic transgressions. Dalmatia consists of thousands of islands, and the region is much higher in potential than Slovenian Adriatic for an application of the underwater survey model. This is due to the variety in coastal landscape, and the presence of geographic features, such as bays, straits, and islets (fig. 6.7).

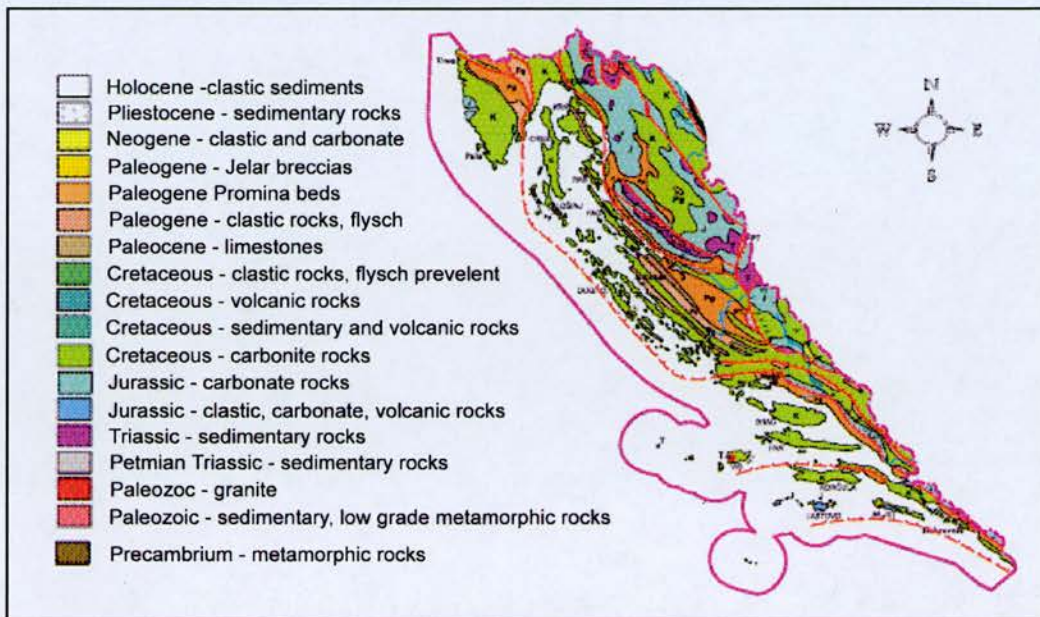


Figure 6.5 Geological map of western Croatia. The coast is mainly carbonate rocks / limestone (green), with some sections of younger of promina beds (orange) (after Velić & Velić 1993).

The dynamic landscape of sea and islands found in Dalmatia contains more sheltered locations than anywhere else in the Adriatic. This is comparable to the eastern Danish islands at which much of the submerged cultural material from Southern Scandinavia has been recovered (Fischer 1993, 2004; S.H. Andersen 1995). The environment suggests practical fieldwork would be easier to undertake, and that desirable preservation conditions would be possible at a number of locations. It follows that Dalmatia is the logical area to test the southern Scandinavian model in the eastern Adriatic. Currents, swell, and sea state are affected by the physical environment, and the regional geology, mainly limestone (fig. 6.5), is forgiving from

a sedimentological perspective. Aerial photography and satellite imagery show that visibility in the water is greatly improved in comparison to the flysch of coastal Slovenia.

The need for underwater survey, and the potential for this method are bolstered by underwater discovery from islet sites (Brusić 1977) and chance finds, such as the artifacts from Baška Voda (Chapter 4, fig. 4.11), which can be considered indications of the potential presence of a submerged site. Such archaeological evidence presents the necessity for an increased awareness and further study, and can be used as base for future fieldwork. Finally, the limestone environment is excellent from a sedimentological perspective, “in spite of thousands of years in the sedimentary environment, all types of karst features (karrens, dolines, poljes, caves, pits, river valleys and canyons, etc.) are still recognizable on the sea bottom” (Surić *et al.* 2002, 91) and it is likely that some of these features contain archaeological potential (Juračić 2002). Slow sedimentation results from the presence of easily soluble carbonate rocks in the drainage area of the eastern Adriatic coastal rivers. Thus “approximately 20% of river-borne material is suspended and the rest is dissolved, so the sea bottom is just partly covered with recent sediments” (Surić *et al.* 2002, 92).

### **Baška Voda**

Satellite images of the nearshore environment west of the Dalmatian town Baška Voda show that the submerged paleocoastline, 10 to 15m underwater, is clearly visible from above. Since this harbor contained isolated lithic finds (Chapter 4, fig. 4.11), now housed in the local museum, a future survey of this submerged environment is proposed (fig 6.6). This could be conducted through linear swim-line and circular survey (Chapter 5, fig. 5.21) be carried out in a matter of a few days, given appropriate conditions, proper equipment and a capable survey team.



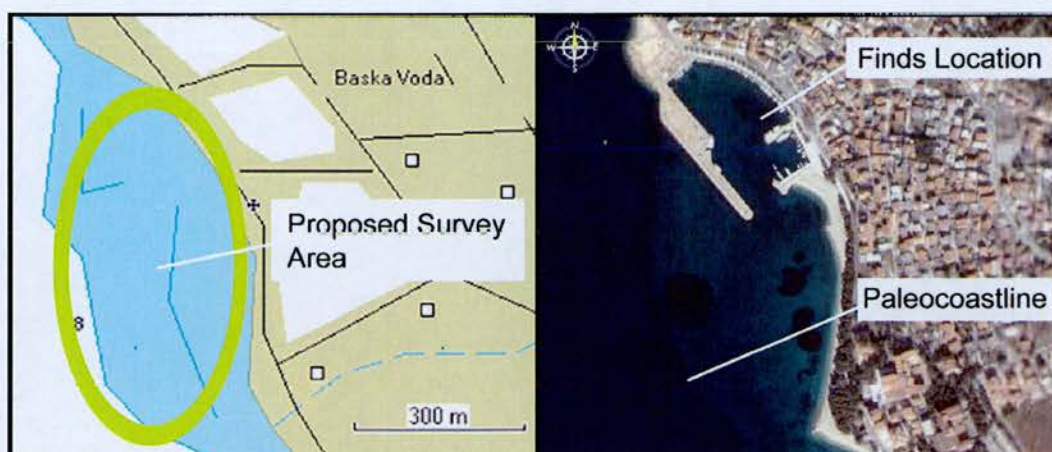


Figure 6.6 Approximate location of prehistoric finds and paleocoastline visible from satellite imagery at Baška Voda. A proposed survey area near the Dalmatian town is suggested (left)

### Dugi Otok: A case study of potential survey locations

Dugi Otok (Long Island) is presented herein as a case study for potential survey sites in Dalmatia. It should be noted that numerous locations exist throughout the region, and thus Dugi Otok is discussed as one example in which survey locations appear to be high-potential according to the presupposition model, sedimentation, and sea conditions. Four potential locations for survey have been suggested for Dugi Otok (fig. 6.7). Each location described herein has been selected for at least one example of high-probability in presupposing late stone age sites based on the model. As noted, satellite images are used in conjuncture with electronic bathymetric charts in the examples listed. A fifth location, not based on the presupposition model, will be discussed later in this chapter.

Location 1 (fig. 6.6) contains a number of geographic conditions defined by the presupposition model: straits, islands, and bays are found within the sheltered Bay of *Tanjer*. Depths within this sheltered environment are between 1m and 25m, and numerous areas of this bay could be surveyed employing various survey methods.<sup>141</sup> Locations 2 and 3 display straits created by islands and headlands. Such locations would be ideal for both fishing and shellfish collections, and the straits would

<sup>141</sup> This is best established on location.



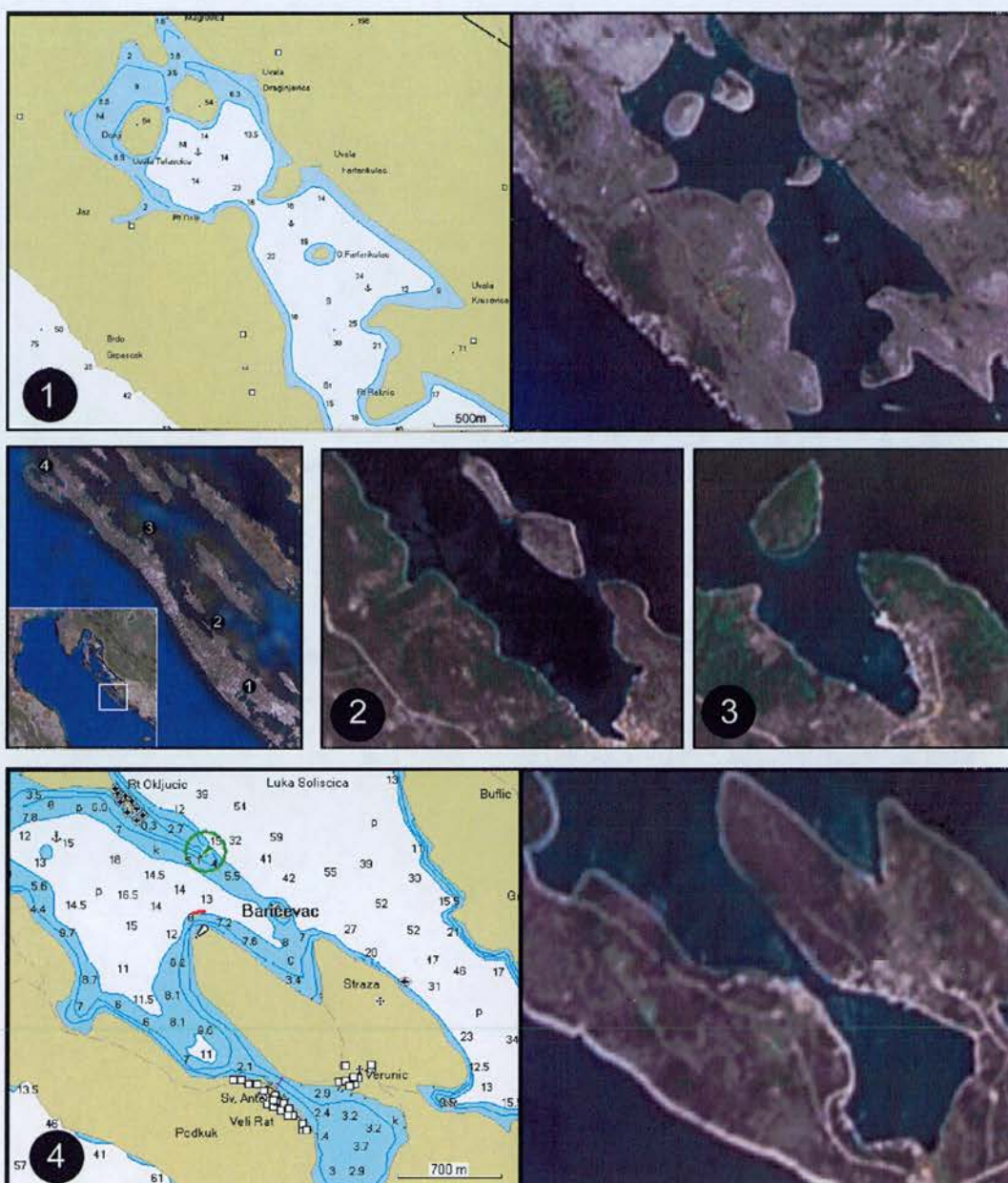


Figure 6.7 Satellite images of potential survey areas on Dugi Otok (Examples 1 and 4 are shown next to an electronic nautical chart). The sites include islands, straits, inlets and bays, and are amongst potential survey locations based on the presupposition model.

presumably have covered shorter distances during times of lower sea-levels.

Location 4 would have been an excellent fishery location as it is a narrow entrance into a shallow bay or inlet. This shallow depth would have been practical for fishery locations using nets and traps in particular. Thus, the multiple sites on Dugi Otok which appear appropriate for late stone age underwater discovery could be



thoroughly surveyed in a single project given ample time appropriate staff, equipment and weather conditions.

#### 6.3.4 Palagruža

Palagruža, the two small islands in the central Adriatic Sea are locations, provide evidence for early Neolithic sea-faring and waterway expansion by migrating people and culture (Forenbaher & Kaiser 2005; Farr 2006). The previous fieldwork conducted at Palagruža has shown that these islands contain at least two sites at which Neolithic material has been recovered, as well as the quarry location for flint on the smaller Mala Palagruža. What remains to be seen, however, is whether or not prehistoric archaeological material can be recovered in submarine environment surrounding these islands. Initial studies conducted by Forenbaher *et al.* (1994) did include underwater archaeological survey for one season on both the North and South sides of the larger island. Nevertheless, consistent with the regional paradigm, the underwater surveyors “did their standard thing of looking for amphorae, Roman anchors and the like.” (Forenbaher, pers. com.).<sup>142</sup> Forenbaher also suggested the potential of local caves near the water surface used by Mediterranean seals (*Monachus monachus*) before they became endangered and nearly disappeared from the region. Depending on the depth of such cave locations, there may be sheltered areas, which could yield archaeological material. The difficulty at Palagruža consists in the lack of modern inhabitants and thus regional, or local, knowledge of the submerged environment is unavailable. The lack of a modern population may also be advantageous, since there should presumably be less modern disturbance in the nearshore environment.

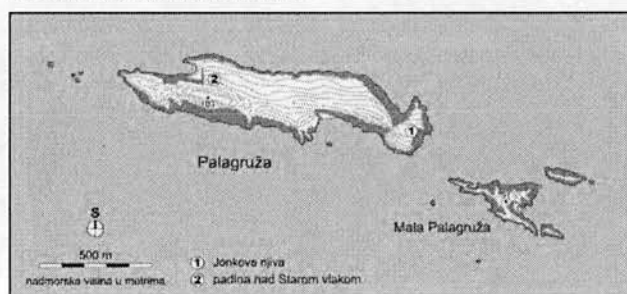


Figure 6.8 Palagruža in the central Adriatic have been surveyed, however the focus was on classic underwater material rather than Stone Age discovery (after Forenbaher et al. 1999).

<sup>142</sup> Personal communication referenced as a direct quotation from an email on October 2, 2006.

### 6.3.5 Submerged Caves of the East Adriatic

Limestone coastal settings can be advantageous for underwater archaeological site discovery as shown in the cases of Cosquer cave (Clottes et. al 1992), and the paleoindian sites from karstic sinkholes in Florida, such as at Warm Mineral Springs (Cockrell 1980; Mclean 2001). Furthermore Edera, Mala Triglavca and Vela Spilja are examples of limestone cave sites found above sea level in the *Caput Adriae* and Dalmatia. Due to the geology of the region, the Slovenian coast does not contain caves though the Croatian Adriatic does contain submerged caves worth investigating. The disadvantage of cave sites on land, is that they can be subjected to numerous periods of human occupation, which cause disturbance and confusion, given artifact mobility and disturbed stratigraphy. In addition to later contamination and human disturbance or exploitation of caves, come thousands of years of exposure to natural elements over the millennia. Such later human disturbance would be impossible in submerged caves, potentially inhabited in the late Pleistocene and early Holocene, prior to their submergence. While transgression would have potentially disturbed an archaeological site, this same factor would protect material from later generations of human occupation, and thus potential confusion due to intruding material culture. Disadvantages, of course, include problems of bio-disturbance, marine sedimentation, erosion, and of the initial process of inundation. Since no underwater archaeological sites have been documented from submerged caves of the Adriatic, this area is wide-open to potential discovery. Other central Adriatic Islands may also provide submerged evidence for early Neolithic seafaring.

#### Y-Cave, Dugi Otok

Returning to the case study at Dugi Otok, there exists at least one submerged cave on this island, which could reasonably have been inhabited prior to the transgression of the Adriatic Sea. A marine geological study conducted by Juračić *et al.* (2002), and details from this report will be discussed for the archaeological potential of Y-

cave. The cave itself lies on the southwest coast of Dugi Otok<sup>143</sup> and is composed of Turonian limestone. Juračić notes that there are other submarine and coastal caves in the vicinity of Y-cave, which provide further archaeological research potential.

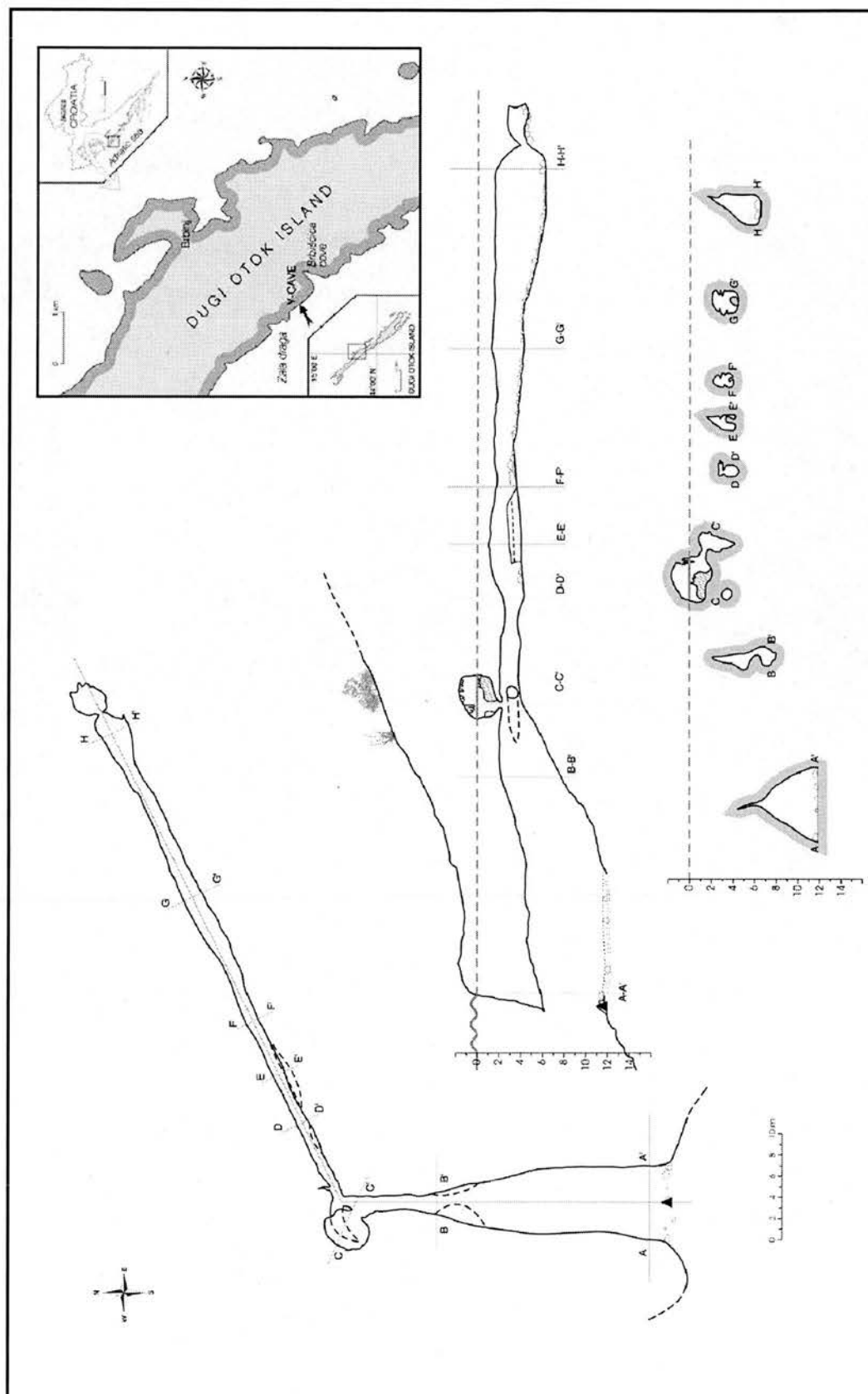
The cave is 12m below actual sea level and was diagrammed by a geological team (fig 6.9). The entrance is 6m high with a flattened floor covered in fine sediments. Despite no archaeological aspects included in their study of the cave, Juračić mentions the archaeological potential with notable enthusiasm. The cave narrows and becomes a channel, which extends for over half of the cave's total length of 87m. The surface material has undergone bio-disturbances, notably from bivalves and sponges, however there is no mention of disturbance on the cave floor. Additionally, due to the fine sediments in this cave, there is a heightened possibility of anaerobic conditions under the seabed, and thus positive conditions for the preservation of archaeological material. Evidence of available freshwater in the cave, shown through the presence of spaleothems, is also a positive indication for human habitation (Juračić *et al.* 2002).

The transgression of the Adriatic would have flooded Y-cave sometime around the late 6<sup>th</sup> Millennium BC, according to the most recent sea level rise determinations (van Andel 1990; Lambeck *et al.* 2004). Thus, it follows that the cave itself could have been occupied by local groups of the final Pleistocene and early Holocene until this time. Local chronology (Forenbaher & Miracle 2005) suggests that the cave could have been inhabited during the Mesolithic and the earliest Neolithic occupations based on its depth at 12m at the mouth of the cave. If early Neolithic dates from Dalmatia begin around 6000 BC (Chapter 3, fig. 3.16), it is possible that caves, at approximately 5 to 15m depth, found along the Dalmatian coast, could potentially have been occupied by these early Neolithic seafarers.

Figure 6.9 (following page) Y-Cave, the underwater site on Dugi Otok has been studied by marine geologists, but has not been surveyed for archaeological material (after Juračić *et al.* 2002).

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<sup>143</sup> Juračić lists the location of Y-cave as 14° 59' 04.8" E, 44° 03' 27.3" N.





A thorough survey at Y-Cave could be conducted at this location using SCUBA equipment, and at a depth of 10m the sea bed is highly accessible for diving. Additionally, surface air compressor with continuous air supply fed into the cave from shore could be an option for such a location. Test pits or trenches should be conducted near the mouth of the cave, particularly in the first third of the cave. Since diving in caves is very dangerous, safety measures would need to be carefully considered. Additionally, logistics, including lighting the site would be necessary, as visibility might be problematic in such an enclosed environment. Regardless of archaeological material, caves such as this one can be used to date the regional transgressions of the Adriatic Sea. Studies in which submerged speleothems are analyzed for sea-level rise data have been conducted in similar underwater karstic features in Croatia (Surić *et al.* 2004). Thus, an archaeological survey of Y-cave, conducted multi-functionally, could yield archaeological and paleoenvironmental data.

#### **6.3.6 The Gulf of Kotor**

The southern most point of coastal Croatia ends at the Gulf of Kotor, which lies mainly in the political territory of Montenegro. Though fjord-like in size and shape, this large Adriatic inlet is a submerged river valley<sup>144</sup> and contains numerous potential underwater archaeological survey locations. Additionally, the cave site Spila Pećina (or Spila iznad Perasta) on the north-eastern tip of the gulf was occupied from the early Neolithic, exemplified by Impresso, Danilo, and Hvar type material (Batović 1979, maps 7-9; Marković 1985). This illustrates the presence of local Neolithic groups in the Gulf, and strengthens the potential for underwater discovery.

The difficulties of underwater archaeological survey Kotor region concern local sedimentological aspects and conditions and modern disturbance. The gulf is host to tourism, modern ship yards and a variety of maritime activities. Additionally,

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<sup>144</sup> the word 'fjord' is in fact used in the tourism industries, and within the popular culture of the region.

because the gulf is a result of a submerged river valley, the soil conditions may be detrimental from a sedimentological perspective. Further environmental background would need to be studied on a local scale within the gulf. However, given the obvious geographical features, and the recorded prehistoric activity in the region, the Gulf of Kotor is a potential location for future underwater fieldwork.

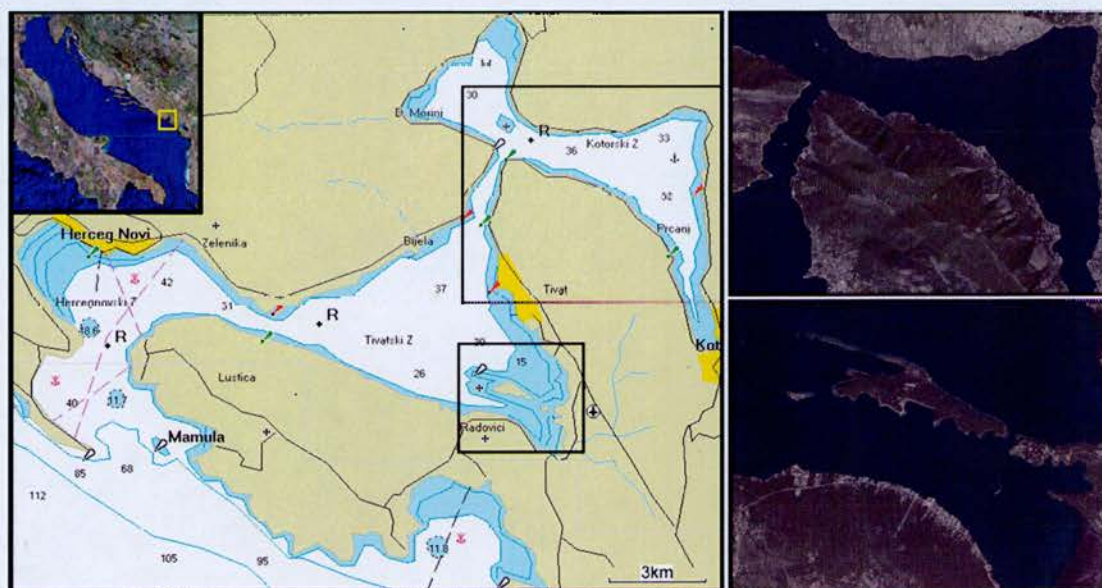


Figure 6.10 The Gulf of Kotor on the Croatian, Montenegro border. There are a number of locations of potential survey in this large inlet.

#### 6.4 Conclusion: Future Studies

Potential locations for submerged archaeological discovery along the eastern Adriatic extending from Slovenia to southern Croatia have been described. These theoretical locations for survey are based on a variety of indicators including previously discovered sites (or isolated finds), high-potential areas for prehistoric human occupation such as cave sites, and those locations defined by the presupposition model. Due to the theoretical nature of such the proposed fieldwork, additional considerations, logistical difficulties, and local variables will inevitably arise during later stages of fieldwork planning and actual survey. Thus, the underwater archaeologist must be able to interpret the available data using the most accurate information and tools available. This helps to exclude the obvious sites,



which are archaeologically void of material due to conditions of erosion, sedimentation or modern human disturbance. As suggested, the combined use of satellite imagery with bathymetric charts and available marine geological and biological data are the first variables to consider when planning such fieldwork.

Logistical elements are inherently important to underwater archaeology. Nearly all proposed sites discussed would require the use of a boat suitable for scientific research. This and other practical needs force the underwater archaeologist to confront a financial reality, and the proposed studies in Croatia are no exception. This unfortunate fact means that significant funding must be attained to adequately, safely and scientifically conduct such an underwater archaeological survey. Additional assistance and volunteers must also be sought for local knowledge and support. Additionally, legal guidelines must be followed and official permits are required.

Finally, sites listed in this chapter have been suggested as possible areas for underwater archaeological discovery, though there are many areas in Croatia which may yield submerged prehistoric archaeological material. The dynamic limestone island environments of Dalmatia are of particular interest. Given that previous discovery made without any concerted effort in seeking Stone Age material (Chapter 4, fig. 4.9, 4.11), and a continued interest and research in prehistory has been demonstrated within the underwater archaeological community (e.g. Gaspari & Erič 2006), future submerged Stone Age discovery in the eastern Adriatic is imminent. The regional paradigm has been for the underwater archaeological focus to be mainly on Classical material and shipwreck sites; it is not surprising that the eastern Adriatic has yielded mainly finds historic and Classical in age. It must be emphasized that the search for underwater prehistoric material differs from that of larger maritime features or more familiar Roman finds such as Amphorae. Nevertheless, the recently discovered Zalog pri Verdu indicate that an interest in submerged Mesolithic material exists in Slovenia, and future interest in the discovery of submerged prehistoric material will surely turn to the eastern Adriatic.

## Conclusion



The underwater survey of the Slovenian Adriatic was inspired by a need to further define the prehistoric record along the coast of northern Istria where only limited Mesolithic and Neolithic material has been recorded. While karstic cave sites exist near Trieste and Divača, a lack of open air sites has prompted the question of the location of the earliest Neolithic and final Mesolithic sites of the *Caput Adriae*. Does the suggested date of c.5600 BC represent the earliest Neolithic, or is this date too late? Furthermore, there continues to be discussions regarding the Neolithization process in the region: the possible immigration of farmers or pastoralists, followed by the spread of such farming communities, or alternatively, the adoption of this new subsistence by local foragers, beginning with the highest quality soils and then moving on to colonize marginal zones. Unfortunately, these research questions cannot be answered with certainty at this time. Further fieldwork is required, and there remains the important task of further defining the role of the Adriatic coast in prehistory.

Karst sites currently represent the majority of the archeological record concerned with the last hunter-gatherers and earliest pastoralists in the region, but why are no sites found on the more fertile flysch soils near the coast? The answer lies in the composition of the matrix, limited preservation, and the destruction of such open air sites through erosion, and modern disturbances such as farming, military operations and construction. It is also likely that research interests, modern politics, funding, and survey strategy have impacted the archaeological record, yielding only sporadic evidence of a coastal occupation along Slovenian Istria. If coastal occupations did exist during the Mesolithic and earliest Neolithic, the archaeological remains that survived the transgression must now lie under the Holocene sediments of the seafloor.

The submerged discoveries from the Slovenian Adriatic from the 2005 survey are not Mesolithic or early Neolithic, though artifacts and features recorded during this pilot study do provide insight for future fieldwork. The discovery of ancient ceramic material near Piran is relatively predictable based on the history and known submerged archaeological sites of the Slovenian coast. Given the importance of

northern Istria during Classical and historic periods, the presence of such material is not a surprise. The feature found near Strunjan point, is a potentially new maritime discovery, and could be the first ancient ballast found along the Slovenian coast. Furthermore, the small re-worked chert knife found near the point of Piran, can be typologically associated with the late Neolithic through contemporary examples from northern Italy, southern Germany, and the Alpine region. This is the first late Neolithic knife of this type to be discovered in Slovenia, and signals the first conclusive evidence of Neolithic activity near Piran.

The history, theory and methods of underwater archaeology have been discussed, and applied to the underwater archaeological survey of the Slovenian Adriatic in this dissertation. Over the past half century, evidence from sites throughout Europe have begun to demonstrate that underwater archaeological methods can provide data unavailable on land, both through preservation of organic material and by providing access to sites and submerged coastal zones that are not geographically available to land archaeologists. The Adriatic has long been determined as a potential location for underwater research of transgressed cultural landscapes, and the study presented herein signals the beginning of a practical approach to underwater site discovery in the region. Furthermore, techniques for predictive modeling of underwater archaeological sites have been described and the first application of the southern Scandinavian model has been conducted in Mediterranean Europe.

Underwater archaeological fieldwork is inherently logistically intensive. Given the challenges of legal considerations, weather conditions, equipment, staff training, and limited financial resources, the two months spent surveying the Slovenian Adriatic were successful in terms of implementation and methodology. The primary difficulty during the survey was caused by the local geology of Eocene flysch and the sedimentation of the seabed. It can be concluded that archaeological material will be difficult, if not impossible to discover by non-disturbance survey in a majority of the nearshore environments of Slovenian Adriatic. Test excavations or core sampling are required to confirm environmental, mainly sedimentological factors, and to search for archaeological material along much of the Slovenian coast, particularly in areas

such as river mouths where the fertile alluvial soils may have been exploited by early farmers. Nevertheless, localized areas that are clear of excessive Holocene sediments do exist and some of these locations have proven to contain cultural material.

Recent discussions of the underwater approach to prehistory have prompted the following questions in the United Kingdom, concerning management and conservation: "Is submarine prehistory simply an extension of terrestrial prehistory, or does it amount to a distinctive subject in its own right? ... Is submarine prehistory essentially a branch of the natural sciences, or is it one of the humanities with a central focus on culture?" (Firth 2004, 89).

The variety of methodology, and results from underwater prehistory discovery have shown that early Holocene sea level rise, studied mainly through earth sciences, biology, and chemistry is increasingly important in the search for submerged cultural activity. Fischer's presupposition model focuses on the discovery of Mesolithic human activity in southern Scandinavia, however, such predictive modeling would be impossible without the study of the paleoenvironment. Defining geological and topographical developments within the cultural landscape is critical to establishing the physical characteristics within which prehistoric people existed. In southern Scandinavia, a comprehensive understanding of the physical geography has assisted not only in the discovery of underwater archaeological material, but also in establishing a tested method for the presupposition of these late Stone Age sites.

Future studies applied to submarine prehistoric landscapes of the Adriatic will be greatly aided by reconstructed paleoenvironments. Thus, the potential for underwater archaeological site discovery in the eastern Adriatic will rely extensively on the natural sciences, and be supported by technological advance in diving, seabed profiling, cartography, and satellite imagery. Due to the cultural nature of submerged archaeological material, and the importance of environmental variables to prehistoric human populations, the study of submerged prehistory demands the consideration and methodology of both natural and social sciences.

Finally, through careful study of nautical charts, satellite imagery and the experience of surveying the northern Adriatic in Slovenia, it has been shown that a greater potential for submerged Mesolithic and early Neolithic sites exists in Croatian waters. This is based on topography of a region that can be considered appropriate for testing the southern Scandinavian research model, as well as favorable sedimentological conditions. Additionally, submerged sea caves exist at depths appropriate for investigations associated with the Pleistocene and early Holocene. Results from the 2005 survey of the Slovenian Adriatic, and the survey locations proposed for Croatia, provide a foundation for future underwater archaeological fieldwork along the submerged coastal zones of the eastern Adriatic.



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## Appendix

## Radiocarbon Calibrations

Site / Description	Mean Probability (Cal BC)	<sup>14</sup> C age bp	corrected error (±)	Referenced Publication	Lab Code
Cosquer Cave - Charcoal	<b>19896</b>	18440	440	<i>Clottes et al. 1992</i>	LY-5558
Point de la courege	<b>5700</b>	6800	90	<i>Geddes et al. 1983</i>	MC-788
Point de la courege	<b>4235</b>	5410	140	<i>Geddes et al. 1983</i>	Gif-2747
Point de la courege	<b>1487</b>	3210	140	<i>Geddes et al. 1983</i>	Gif-2748
Point de la courege	<b>4780</b>	5900	140	<i>Geddes et al. 1983</i>	Gif-2749
Marmotta - wooden pile	<b>5740</b>	6874	7	<i>Bernicchia et al. 2006</i>	see ref.
Marmotta - wooden pile	<b>5128</b>	6189	7	<i>Bernicchia et al. 2006</i>	see ref.
Kefar Samir - Tabor Oak (Quercus)	<b>4557</b>	5700	140	<i>Raban 1983</i>	see ref.
Kefar Samir - olive remains	<b>4460</b>	5630	55	<i>Galili et al. 1997</i>	RT-1929A
Newe Yam - Charcoal	<b>2989</b>	4360	395	<i>Wrechner 1983</i>	see ref.
Ertebolle Logboat - Lystrup	<b>5506</b>	6550	105	<i>Christensen 1997</i>	K-6012
Villingbaek fishtrap - wood	<b>6036</b>	7160	120	<i>Pedersen 1995</i>	see ref.
Timmendorf Nordmole - Dog Tibia	<b>4450</b>	5621	29	<i>Lubke 2001</i>	KIA 8444
Timmendorf Nordmole - burned food	<b>4162</b>	5335	29	<i>Lubke 2001</i>	KIA 8447
Oleslyst fishing structure - wood	<b>3220</b>	4535	65	<i>Pedersen 1995</i>	see ref.
Oleslyst fishing structure - wood	<b>3408</b>	4620	70	<i>Pedersen 1997</i>	K-6436
Pupcina Pec - Hearth/Charcoal	<b>10569</b>	10610	200	<i>Miracle 2001</i>	Z-2574
Viktorjev Spodmol - Elk tooth	<b>9390</b>	9930	50	<i>Turk 2004</i>	see ref.
Viktorjev - Bone, Spit 15	<b>7367</b>	8300	50	<i>Turk 2004</i>	see ref.
Viktorjev Spodmol - Bone, Spit 16	<b>8976</b>	9560	50	<i>Turk 2004</i>	see ref.
Pupcina Pec - Mesolithic layer	<b>7827</b>	8708	170	<i>Miracle 1997</i>	Z-2635
Mesolithic 'midden' level 25	<b>8963</b>	9590	180	<i>Miracle 1997</i>	Z-2572
Valmaine 2 - early Mesolithic layer	<b>8698</b>	9410	80	<i>Biagi et al. 1995</i>	GrN- 20093
Valmaine 2 - early Mesolithic layer	<b>9010</b>	9630	100	<i>Biagi et al. 1995</i>	GrN- 20890
Rodento - Charcoal	<b>8001</b>	8880	150	<i>Biagi et al. 1995</i>	GrN- 19590

<b>Grotta Benussi Layer 5/6</b>	<b>7676</b>	8650	70	<i>Riedel 1975</i>	R-1045A
<b>Grotta d'ella Edera - hearth</b>	<b>5621</b>	6700	130	<i>Biagi et al. 1993</i>	GX-19569
<b>Piancanada</b>	<b>5662</b>	6751	108	<i>Pessina &amp; Rottoli 1996</i>	R-2705
<b>Vizula - animal bone strata 3</b>	<b>5760</b>	6850	180	<i>Chapman &amp; Muller 1990</i>	HD-12093
<b>Breg</b>	<b>5742</b>	6830	180	<i>Frelih 1986</i>	see reference
<b>Barje Resnikov prekop</b>	<b>4720</b>	5856	93	<i>Tomaz 1997</i>	see reference
<b>Maharski Prekop - bone (ovis)</b>	<b>3543</b>	4740	40	<i>Mlekuz 2006</i>	Beta- 219606
<b>Environmental Core - Piran V6*</b>	<b>8109</b>	9120	120	<i>Faganeli et al. 1987</i>	see ref.
<b>Environmental Core - GT 1*</b>	<b>8038</b>	9030	70	<i>Ogrinc et al. 2005</i>	see ref.
<b>Environmental Core - GT 2*</b>	<b>8229</b>	9160	50	<i>Ogrinc et al. 2005</i>	see ref.
<b>Environmental Core - GT 2*</b>	<b>4510</b>	5860	40	<i>Ogrinc et al. 2005</i>	see ref.
<b>Environmental Core - GT 3*</b>	<b>8229</b>	9160	50	<i>Ogrinc et al. 2005</i>	see ref.
<b>Environmental Core - GT 3*</b>	<b>3004</b>	4560	35	<i>Ogrinc et al. 2005</i>	see ref.
<p>Dates calibrated at IntCal04 setting            Dates marked * calibrated at <i>Mixed Marine NoHem</i> setting            CALIB RADIOCARBON CALIBRATION PROGRAM* Rev 5.0.1            Copyright 1986-2005 M Stuiver and PJ Reimer</p>					

Table A.1 Radiocarbon data from text, calibrated in *Calib*, version 5.0.1

Cyprus

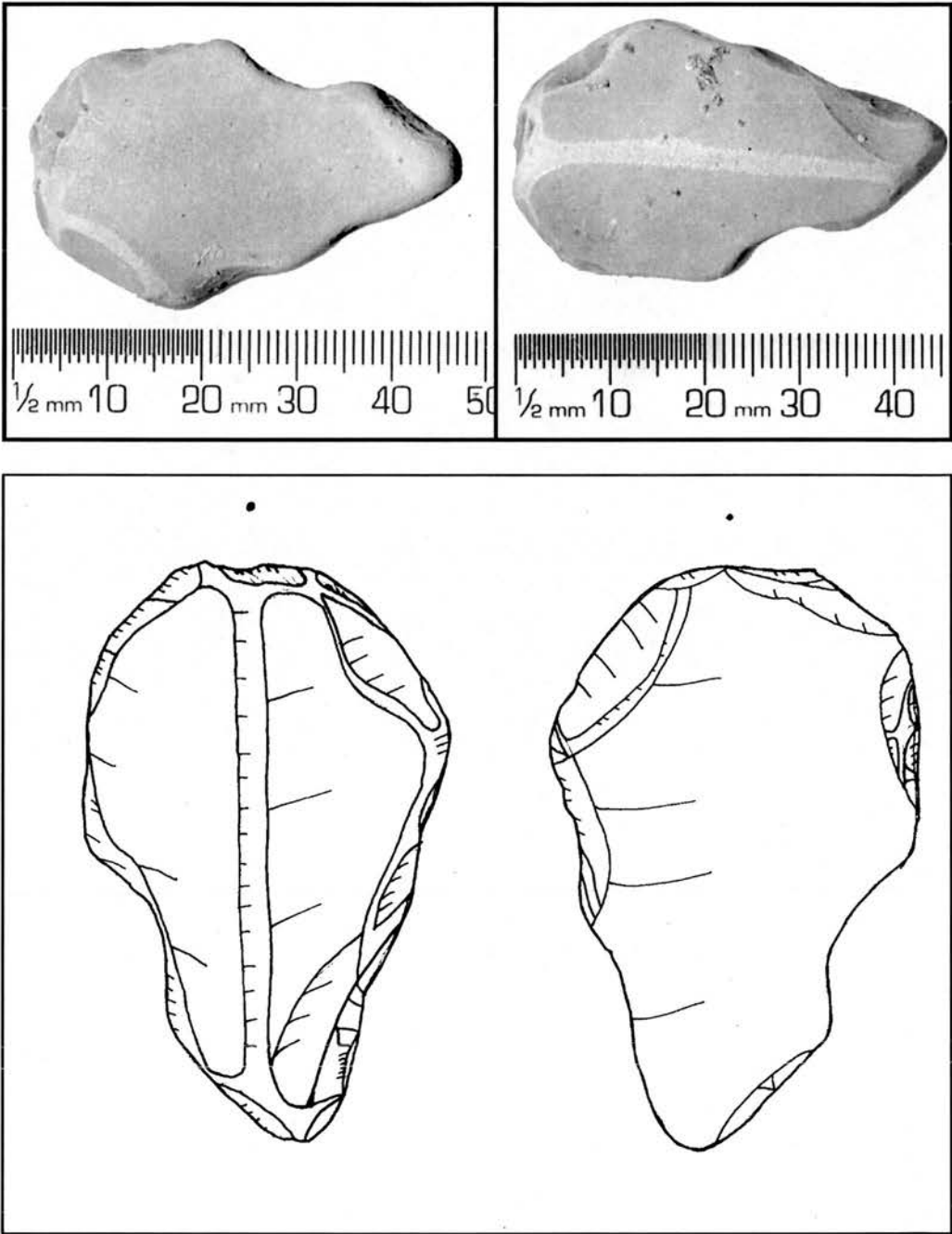


Figure A.1 Lithic artifact from Dreamer's Bay, Cyprus. This worked lithic artifact was found in Dreamer's Bay, Cyprus, by D. Howitt-Marshall. Sketch by G. Ritchie.



## Slovenia: Survey 2005

- Selected Original Dive Logs
- Selected Original Finds Sketches
- Supplemental Survey Photos
- Personnel
- Master Dive Log (Dive Catalogue)

## Selected Original Dive Logs

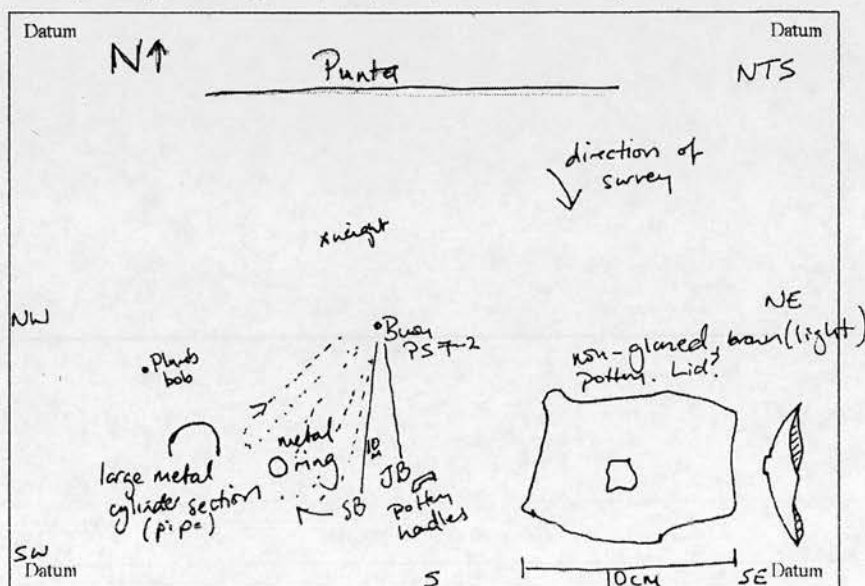
### DIVE LOG

Name: SAMANTHA BROWNLEE Date: 06/07/05 Site/Year: SLO/05 Inits/No: SB/JB

Max. Depth: 10m Dive Times: 1:23 - 2:26 Area: PST-2  
(Punta Santa)

Objectives: Circular survey of Punta Santa bank @ 10m

Sketch (including bottom composition, lithics, timber, ceramics and contexts).



Results/contexts worked, etc. No Neolithic finds. lots of pottery handles, modern glass bottles, glazed pottery sherds, old looking pot lid with nipple like nubbin in middle, unglazed. Sandy, quiet bottom. Corals, lots of shells, v. slight slope, v. slight. Mild & no current. Visibility 4-5 metres.

(use reverse if required)

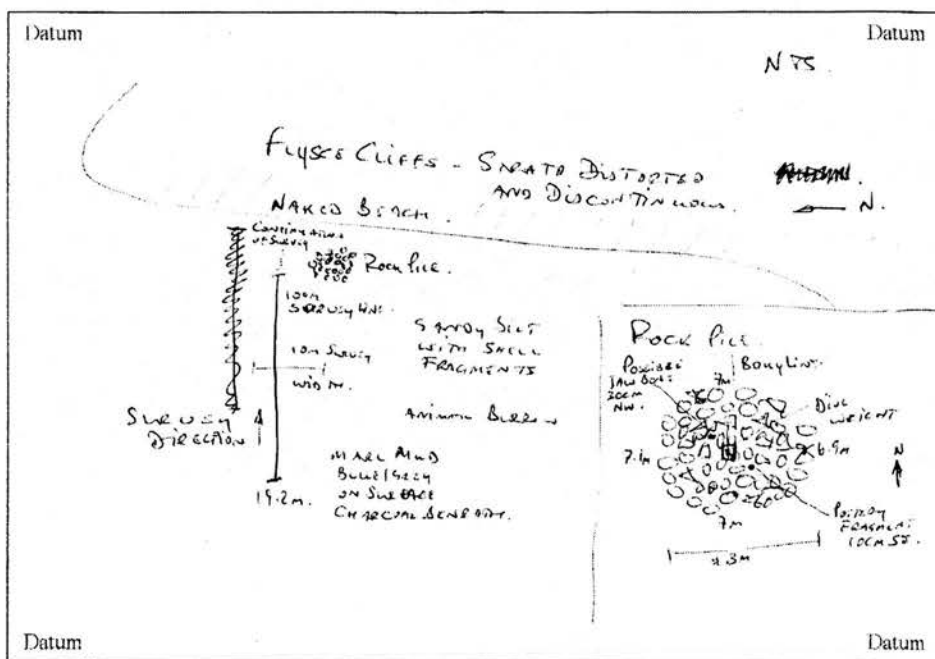
Photographed: Y References: choppy water, clear sky, wld wind Video: Y/N  
Sea Conditions & Weather: choppy water, clear sky, wld wind

# DIVE LOG

Name Philip Cooper Date 16/6/05 Site/Year PC/Jordan  
 Max. Depth 19.2m Dive Times IN 12.03 OUT 12.45 Area   
7.3m IN 14.45 OUT 15.35

Objectives SURVEY BAY NEAR STANTON POINT

Sketch (including bottom composition, lithics, timber, ceramics and contexts).



Results/contexts worked, etc. AT DESCENT POINT SEA BED MARL MUD  
BING GREY ON SURFACE AND CHALKY BLACK UNDERNEATH  
OBSERVABLE GRADIENT ANIMAL BONES IN MUD. SEA BED  
CHANGED TO SANDY SILT ABOUT HALF WAY ALONG SURVEY LINE  
SURVEY CONTINUED BEYOND END OF 100M LINE INTO  
SHALLOW WATER. ROCK PILE OBSERVED. SECOND DIVE  
UNDERTAKEN TO SURVEY ROCK PILE IN MORE DETAIL

(use reverse if required)

Photographed: Y/N References:  Video: Y/N   
 Sea Conditions & Weather: WEATHER FINE, SHELTERED BAY - SEA CALM

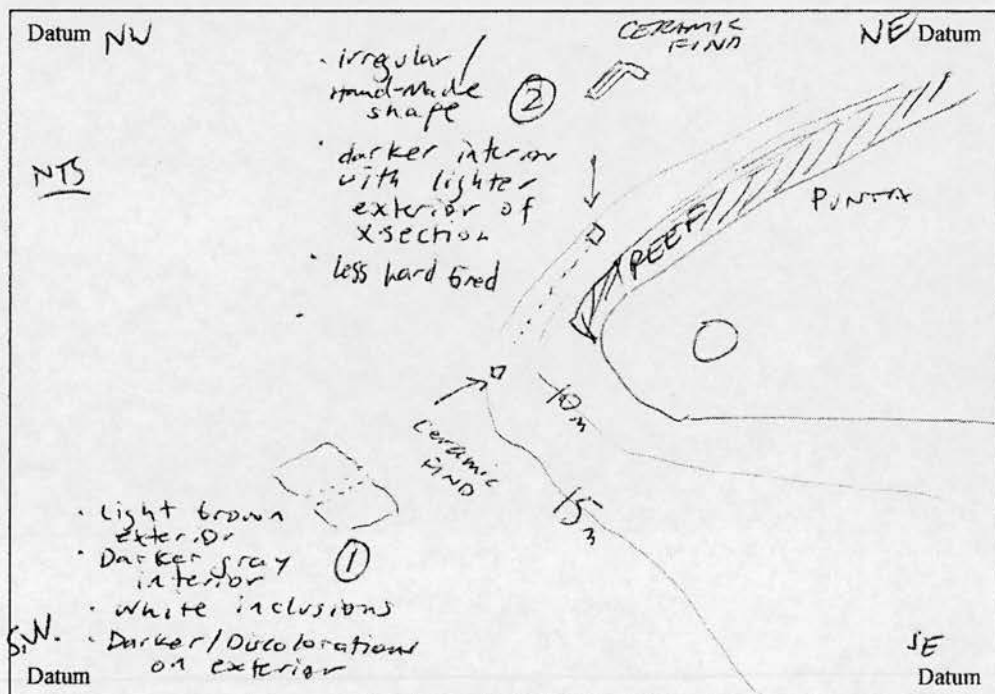
# DIVE LOG

Name J. BENJAMIN Date 10/7/25 Site/Year S20 05 Inits/No. JB-MC

Max. Depth 15m Dive Times 50min Area PUNTA WEST

Objectives DIVE PUNTA WEST WITH MATIA & ZUMER TO LOOK AT CERAMIC FINDS OF POTENTIAL FOR PRE-HISTORIC ARTIFACT - 2 CERAMIC SHARDS - FIND BOTH PIECES, INSPECT, DISCUSS, PHOTOGRAPH

Sketch (including bottom composition, lithics, timber, ceramics and contexts).



Results/contexts worked, etc. FIND CERAMICS - DISCUSSED FINDS WITH MATIA FOR PRE-HISTORIC ASSIGNMENT. FIND 1 = HARD FIRED FIRE PRE-HISTORIC, BUT FIND 2 BETTER SHAPE, LESS HARDENED EXTERIOR, POTENTIAL PRE-HISTORIC FIND - ZUMER PHOTOGRAPHED FINDS AND ACTIVITY - 14m - SANDY BANK BELOW REEF (use reverse if required)

Photographed: Y/N References Y Video: Y/N N  
Sea Conditions & Weather: 1 CALM, 1 SYN, 1 PM WINDY STOP

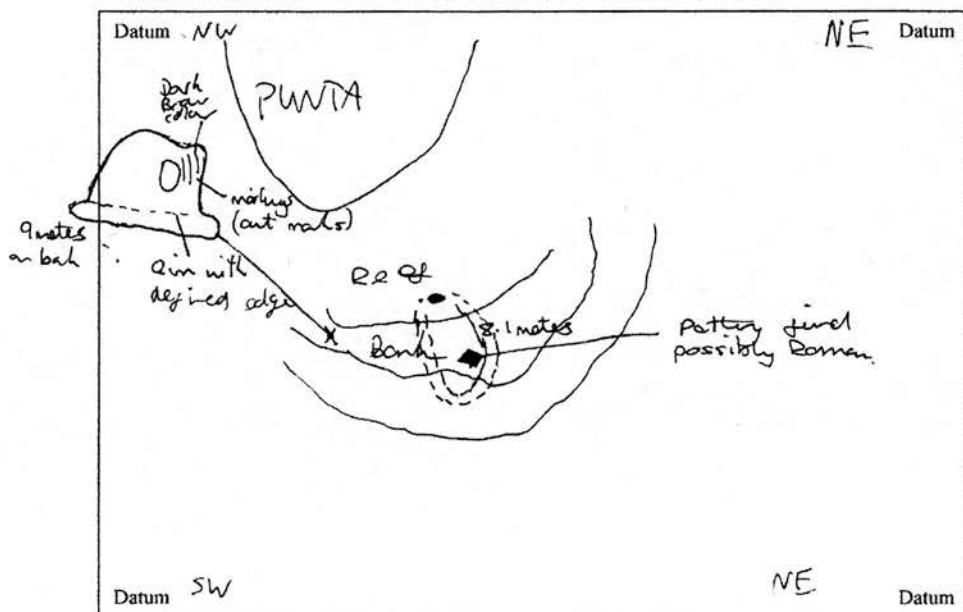
# DIVE LOG

Name: Fiona McLean Date: 17.1.75 Site/Year: 310 05 Inits/No: F.M. 4 JB

Max. Depth: 8.1m Dive Times: 25 min Area: PWTA

Objectives: SURVEY OF BANK

Sketch (including bottom composition, lithics, timber, ceramics and contexts).



Results/contexts worked, etc. Sandy bottom composition  
on bank visibility fair 4+  
Pottery found around 8.1m - unglazed 2nd  
get appear made on wheel possibly Roman  
Brown pottery found at 9m with possible  
cut marks and a defined lip in  
 (use reverse if required)

Photographed: Y/N References: Possibly Roman pottery piece Video: Y/N  
 Sea Conditions & Weather: slight chop, low wind, fair visibility



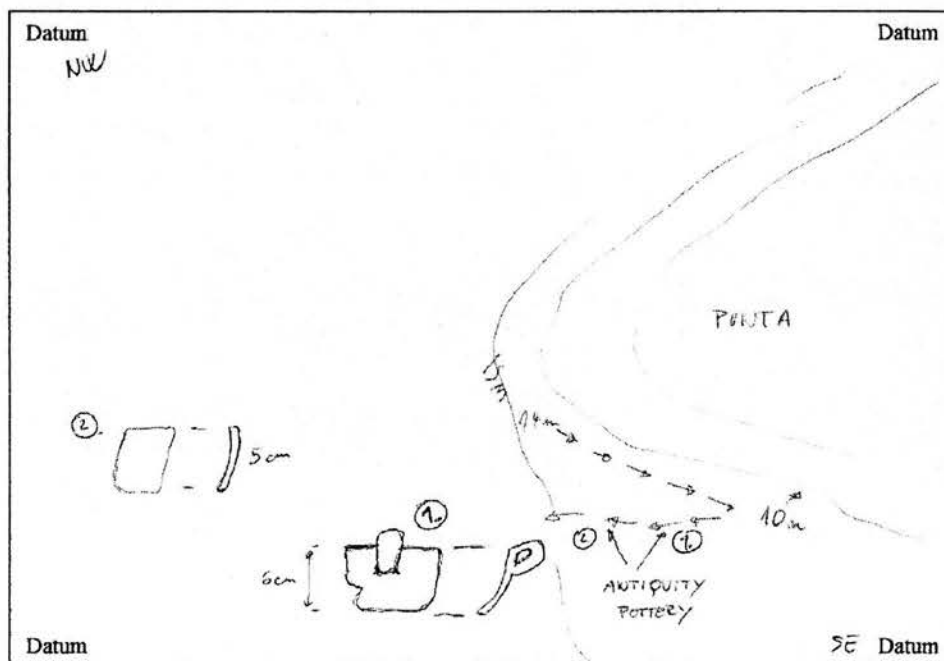
# DIVE LOG

Name H. CRESNAZ Date 17/7/05 Site/Year NO. 55 Inits/No. SB, MC

Max. Depth 19, 3 Dive Times 23 min Area PUNTA

Objectives PUNTA LINEAL SURVEY

Sketch (including bottom composition, lithics, timber, ceramics and contexts).



Results/contexts worked, etc. OBTAINED CONDITIONS AND BOTTOM COMPOSITION  
FEW POT. SHEPDS. - POSSIBLY ANTIQUITY DATE, BUT NO  
EARLIER. MANY NEW SHEPDS. - FROM 2012, 10m  
STRONG CURRENT  
→ THERE WERE TWO SHEPDS. WITH SOFT SURFACE WHICH COULD  
BE ANTIQUITY DATE - LITTLE INCLUSIONS, RED COLOR  
 (use reverse if required)

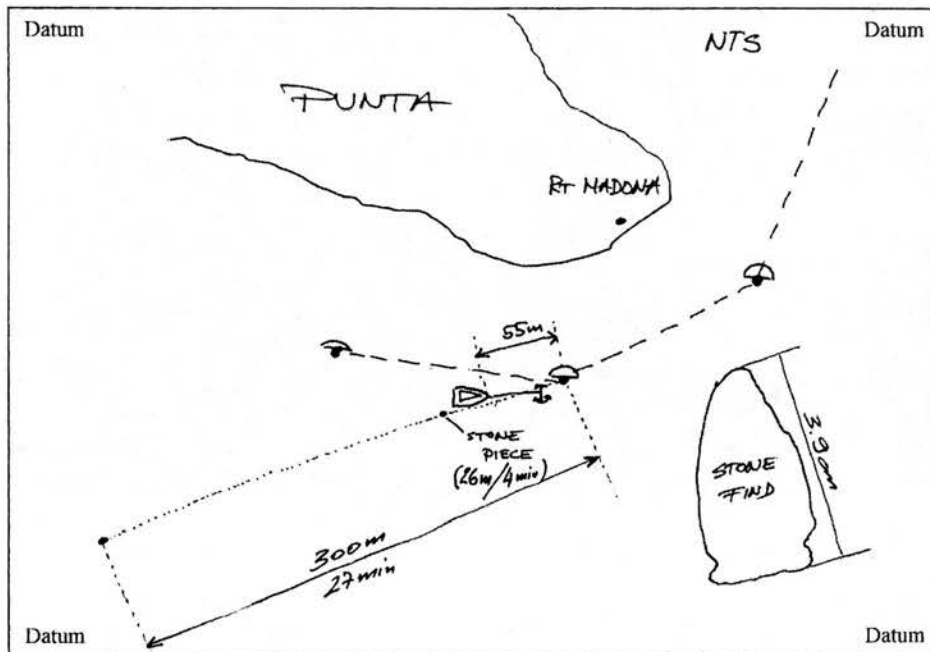
Photographed: YN References: Video: YN  
 Sea Conditions & Weather: CALM, VIS. - OK, V.W. - HOT

# DIVE LOG

Name JERNEY CELESTINA Date 26/07/05 Site/Year SLO-2005 Inits/No.....  
 Max. Depth 27.4m Dive Times 27min Area PUNTA

Objectives Survey

Sketch (including bottom composition, lithics, timber, ceramics and contexts).



Results/contexts worked, etc. During the dive on the fourth minute  
I stuck my hand in the muddy bottom because I was  
to heavy. I felt something hard and then I saw that  
it is a stone shaped like an arrowhead. We continued  
with the dive and surfaced 300m away from the last  
I saw a few rocks and nothing else.

(use reverse if required)

Photographed: Y/N References..... Video: Y/N.....  
 Sea Conditions & Weather: current was strong (1.5m/s)

Original Finds Sketches

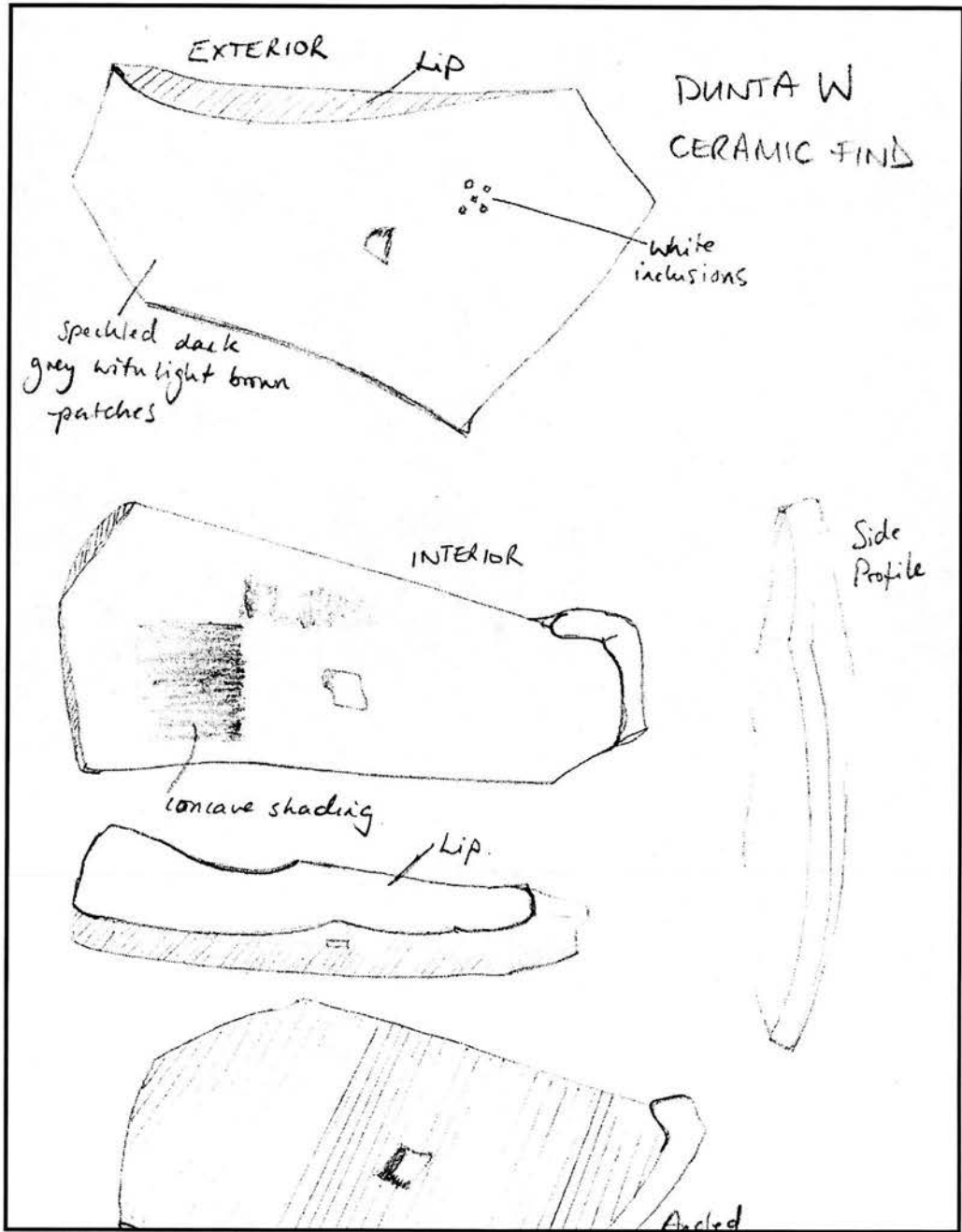


Figure A.2 Sketch of SA05-02 (by S. Brownlee).

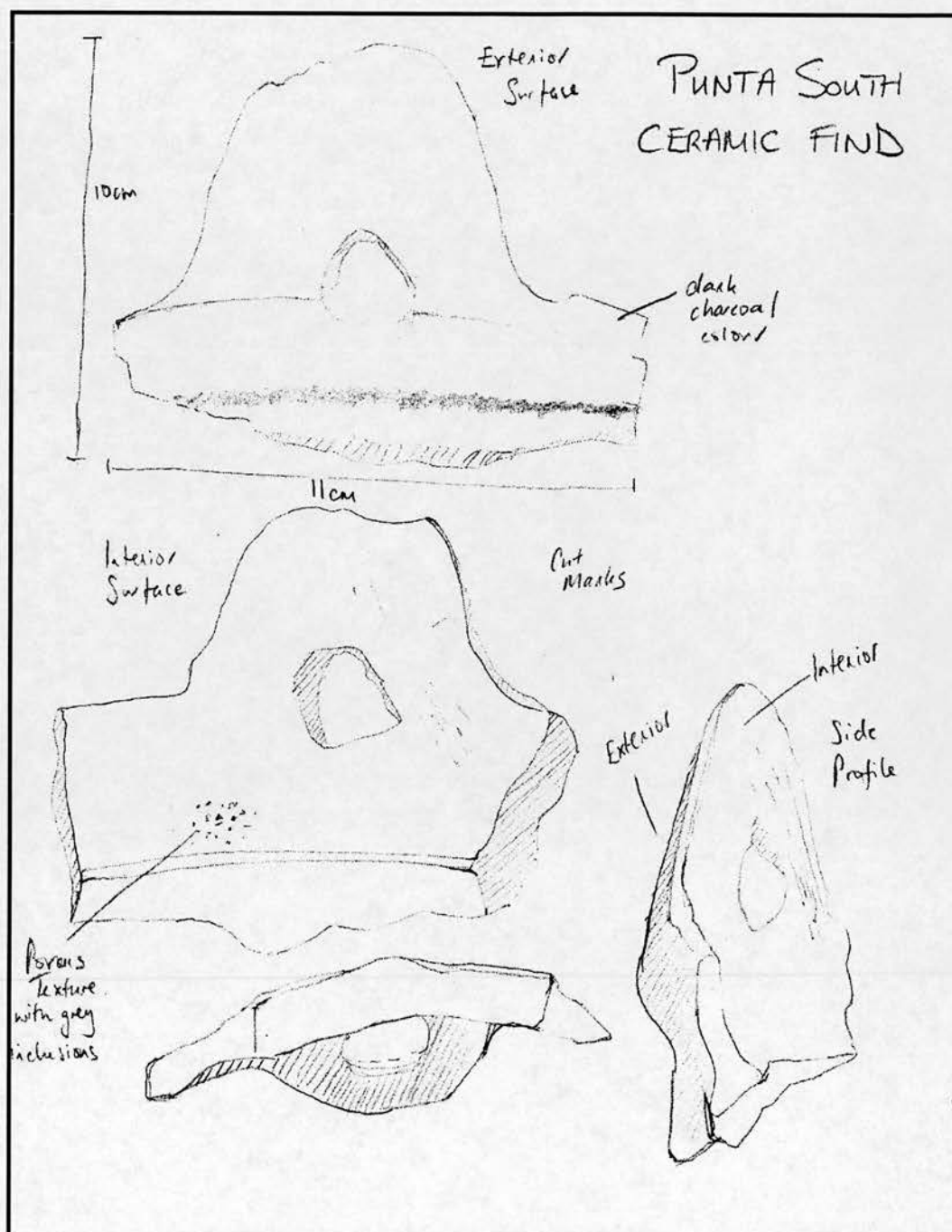


Figure A.3 Sketch of SA05-03 (by S. Brownlee).



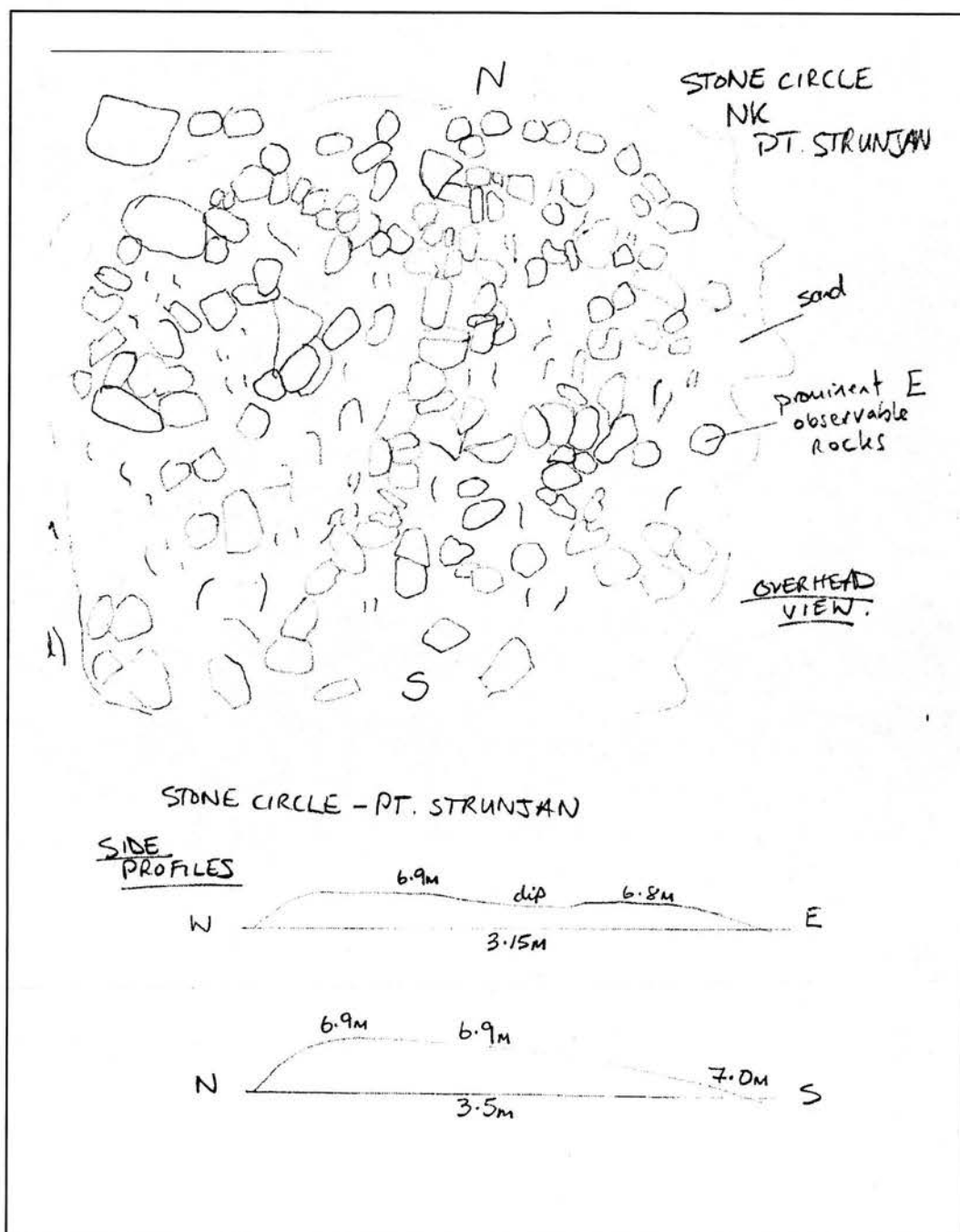


Figure A.4 Sketch of SF05-01 (by S. Brownlee).

## Supplemental Photographs



Figure A.5 Investigating the point of Piran (author with M. Črešnar, photo by J. Žumer).



Figure A.6 Aerial Photography (photo by D. Šefi).



Figure A.7 Preparing the equipment for a linear 'jackstay' survey (photo by Author).



Figure A.8 Surveying the central Gulf of Trieste (photo by D. Shefi).



Figure A.9 Documentation underwater. S. Brownlee near Punta Piran (photo by Author).



Figure A.10 Surveying near Punta Piran (photo by Author).



## Personnel

<b>LAST HUNTERS, FIRST FARMERS OF THE NORTH ADRIATIC</b> AN UNDERWATER ARCHAEOLOGICAL SURVEY			
<b>FIELD TEAM</b>			
<b>NAME</b>	<b>AGE</b>	<b>NATIONALITY</b>	<b>DIVER Qualification</b>
<b>JUNE</b>			
Debra Shefi	23	USA	Instructor, PADI
Philip Cooper	48	England	Rescue Diver, CMAS
Jennifer Breslin	27	Ireland	Commercial Diver, Class III
<b>JULY</b>			
Debra Shefi	23	USA	Dive Instructor, PADI
Samantha Brownlee	20	Ireland	Rescue Diver, PADI
Fiona Mclean	19	Scotland	Rescue DIVER, PADI, BSAC
Additional Volunteers			
Lado Celestina		Slovenia	Naval Instructor, Slovenia
Jernej Celestina		Slovenia	Naval Diver, Slovenia
Matija Črešnar		Slovenia	Advanced Open Water, PADI
Hugo Sedej		Slovenia	Advanced Open Water, PADI
Robert Novak		Slovenia	Divemaster, PADI

Table A.3 Personnel from 2005 field season with relevant data.

## Master Dive Log

Table A.4 (following 2 pages). Master Dive Log from Slovenia Survey 2005. Includes: Dive Catalogue Number, Location, Date, Dive Team, Daily Dive Number, Depth (Soundings), GPS Waypoints (in Easting/Northing).

## DIVELOG - Slovenian Adriatic 2005, Underwater Survey

CATALOGUE	LOCATION	DATE	DIVERS	DIVE No. (DAILY)	SOUNDINGS (m)	WAYPOINTS (DIVE ENTRY)	GPS Coordinates (DEG-MM-MMM)	EASTINGS (in)	TIME IN	EXIT (Linear search) WAYPOINTS	NORTHINGS (out)	EASTINGS (out)	TIME OUT
DS1-070605	PIRAN BAY	7/6/05	JEN+PC	1	20.7 PB1-1		45.30.940	13.31.718	14:43				15:10
DS2-080605	PT. BERNARDIN	8/6/05	JEN+DS	1	11.8 BB1-1		45.30.853	13.34.481	13:05				12:27
DS3-080605	PT. BERNARDIN	8/6/05	DS+PC	2	12.9 BB1-2		45.30.804	13.34.358	16:14				16:41
DS4-080605	PT. BERNARDIN	8/6/05	JEN+JB	3	11.3 BB1-3		45.30.808	13.34.456	15:43	BR1-4	45.30.807	13.34.392	18:10
DS5-090605	PUNTA	9/6/05	DS+PC	1	14.3 PS0-1		45.31.753	13.33.702	13:34	PS0-1A	45.31.816	13.33.741	14:18
DS6-090605	PUNTA	9/6/05	JEN+JB	2	14.4 PS0-2		45.31.816	13.33.741	14:50	PS0-1A	45.31.753	13.33.702	15:32
DS7-130605	FIESA	13/6/05	DS+PC	2	16.6 FI1-1		45.31.767	13.34.523	10:23	FW0-1A	45.31.678	13.34.649	11:05
DS8-130605	FIESA	13/6/05	JEN+JB	3	20.0 FI1-3		45.31.733	13.39.577	11:35	FI1-2	45.31.674	13.39.654	12:16
DS9-130605	IZOLA	13/6/05	JEN+JB	1	20.0 FI1-3		45.32.623	13.39.184	14:42	FI1-4	45.32.673	13.39.328	15:21
DS10-130605	ZLOMGENA NOGA (BRAJDE)	13/6/05	JEN+JB	1	14.8 IZ1-3		45.32.683	13.39.421	15:59	IZ1-4	45.32.683	13.39.421	8:15
DS11-140605	ZLOMGENA NOGA (BRAJDE)	14/6/05	DS+PC+JEN	2	21.4 FI1-1		45.33.434	13.39.686	7:35	FI1-2	45.33.387	13.39.728	9:24
DS12-140605	ZLOMGENA NOGA (BRAJDE)	14/6/05	PC+DS+JB	3	17.4 FI1-2A		45.33.350	13.39.750	8:46	FI1-3	45.33.310	13.39.773	11:04
DS13-140605	ZLOMGENA NOGA (BRAJDE)	14/6/05	JEN+JB	4	18.3 FI1-3A		45.33.214	13.39.832	10:30	FI1-4	45.33.219	13.39.828	12:53
DS14-140605	ZLOMGENA NOGA (BRAJDE)	15/6/05	JEN+JB	1	18.7 FI1-4		45.33.166	13.39.828	11:50	FI1-5	45.33.166	13.39.828	9:07
DS15-150605	ZLOMGENA NOGA (BRAJDE)	15/6/05	JEN+DS	2	21.3 FT2-3		45.33.471	13.30.535	8:35	FT2-2	45.33.415	13.30.561	10:42
DS16-150605	ZLOMGENA NOGA (BRAJDE)	15/6/05	JEN+PC+JEN	3	21.3 FT2-3		45.33.471	13.30.535	10:00	FT2-4	45.33.421	13.30.590	11:57
DS17-150605	ZLOMGENA NOGA (BRAJDE)	15/6/05	JEN+PC+JEN	4	21.6 FT2-5		45.33.469	13.30.644	11:24	FT2-6	45.33.417	13.30.616	13:17
DS18-150605	ZLOMGENA NOGA (BRAJDE)	15/6/05	JEN+DS	1	18.3 NK1-1		45.32.197	13.35.942	12:45	FT2-8	45.33.403	13.30.639	11:29
DS19-160605	PT. STRUNJAN (NAKED BEACH)	16/6/05	JEN+PC	2	18.3 NK1-1		45.32.197	13.35.942	12:04	NK1-2	45.32.187	13.36.049	12:44
DS20-160605	PT. STRUNJAN (NAKED BEACH)	16/6/05	JEN+DS	3	6.5 SP05-001		45.32.187	13.36.049	13:00		45.32.187	13.36.049	13:45
DS21-160605	PT. STRUNJAN (NAKED BEACH)	16/6/05	JEN+PC	4	6.5 SP05-001		45.32.187	13.36.049	14:44		45.32.187	13.36.049	15:35
DS22-170605	PT. STRUNJAN (NAKED BEACH)	17/6/05	DS+PC	1	18.3 NK2-1		45.33.179	13.35.945	9:20		45.32.184	13.36.084	10:11
DS23-170605	PT. STRUNJAN (NAKED BEACH)	17/6/05	JEN+JEN	2	17.7 NK2-4		45.33.126	13.35.885	10:52		45.32.111	13.35.961	11:11
DS24-170605	PT. STRUNJAN (NAKED BEACH)	17/6/05	JEN+JEN	3	17.7 NK2-4		45.33.126	13.35.885	11:36		45.32.155	13.30.068	12:27
DS25-170605	RONEK	17/6/05	DS+PC	4	12.0 R01-1		45.32.411	13.36.615	13:10	R01-2	45.32.399	13.36.691	13:46
DS26-210605	ZLOMGENA NOGA (BRAJDE)	21/6/05	JEN+JEN	1	20.4 FT3-1		45.33.948	13.29.415	7:41	FT3-2	45.33.945	13.29.334	8:15
DS27-210605	ZLOMGENA NOGA (BRAJDE)	21/6/05	DS+PC	2	19.1 FT3-3		45.33.988	13.29.325	9:12	FT3-4	45.33.957	13.29.257	9:47
DS28-210605	ZLOMGENA NOGA (BRAJDE)	21/6/05	JEN+JEN	3	21.8 FT3-5		45.33.998	13.29.184	10:35	FT3-6	45.33.954	13.29.236	11:01
DS29-210605	ZLOMGENA NOGA (BRAJDE)	21/6/05	PC+DS	4	20.3 FT3-7		45.33.471	13.29.054	12:37	FT3-8	45.33.504	13.29.117	13:14
DS30-210605	ZLOMGENA NOGA (BRAJDE)	21/6/05	PC+DS	5	574 FT3-9		45.33.538	13.29.057	13:48	FT3-10	45.33.544	13.29.135	14:14
DS31-220605	FOXHEAD (BRAJDE)	22/6/05	JEN+JEN	1	19.6 FX1-1		45.33.536	13.26.942	7:51	FX1-2	45.33.574	13.26.996	8:14
DS32-220605	FOXHEAD (BRAJDE)	22/6/05	JEN+DS	2	18.7 FX1-4		45.33.640	13.26.947	8:46	FX1-3	45.33.586	13.26.978	9:16
DS33-220605	FOXHEAD (BRAJDE)	22/6/05	PC+JEN	3	19.7 FX1-5		45.33.644	13.27.186	9:57	FX1-6	45.33.636	13.27.266	10:29
DS34-220605	FOXHEAD (BRAJDE)	22/6/05	DS+JB	4	18.7 FX1-7		45.33.545	13.27.599	11:28	FX1-8	45.33.495	13.27.634	11:59
DS35-220605	FOXHEAD (BRAJDE)	22/6/05	JEN+PC	5	21.1 FX1-9		45.33.571	13.27.690	12:52	FX1-10	45.33.524	13.27.730	11:24
DS36-230605	PUNTA SOUTH	23/6/05	JEN+JEN	1	21.2 PS1-1		45.31.668	13.33.737	11:01	PS1-2	45.31.668	13.33.819	12:32
DS37-230605	PUNTA SOUTH	23/6/05	DS+JEN	2	18.6 PS1-2		45.31.668	13.33.819	11:53	PS1-3	45.31.665	13.33.899	14:07
DS38-230605	PUNTA SOUTH	23/6/05	JEN+PC	3	21.1 PS1-4		45.31.709	13.33.734	13:36	PS1-5EX	45.31.731	13.33.786	15:14
DS39-230605	PUNTA SOUTH	23/6/05	JEN+PC	4	18.2 PS1-5		45.31.709	13.33.737	14:38	PS1-5EX2	41.31.732	13.33.719	10:41
DS40-240605	PUNTA SOUTH	24/6/05	DS+JEN	1	12.5 PS2-1		45.31.737	13.33.817	9:58	PS2-1	45.31.737	13.33.817	12:03
DS41-240605	PUNTA SOUTH	24/6/05	JEN+PC	2	13.3 PS2-2		45.31.727	13.33.804	11:10				13:47
DS42-240605	PUNTA SOUTH	24/6/05	DS+JEN	3	11.1 PS2-3		45.31.715	13.33.787	13:08				10:15
DS43-240605	PUNTA SOUTH	24/6/05	PC+JB	4	15.1 PS2-4		45.31.702	13.33.761	14:26				11:23
DS44-270605	PUNTA SOUTH	27/6/05	JEN+JEN	1	20.1 PS3-1		45.31.690	13.33.779	9:36				12:56
DS45-270605	PUNTA SOUTH	27/6/05	DS+PC	2	20.1 PS3-2		45.31.705	13.33.746	10:46				14:05
DS46-270605	PUNTA SOUTH	27/6/05	JEN+JEN	3	15.1 PS3-3		45.31.699	13.33.776	12:16				10:09
DS47-270605	PUNTA SOUTH	27/6/05	DS+PC	4	15.1 PS3-4		45.31.702	13.33.761	13:22				11:15
DS48-280605	PUNTA SOUTH	28/6/05	JEN+JEN	1	18.4 PS4-1		45.31.724	13.33.720	9:30				12:44
DS49-280605	PUNTA SOUTH	28/6/05	DS+PC	2	19.4 PS4-2		45.31.732	13.33.703	10:36				12:44
DS50-280605	PUNTA SOUTH	28/6/05	JEN+JEN	3	12.5 PS4-3		45.31.272	13.33.728	12:03				12:44

DS51-280605	PUNTA SOUTH	28/6/05	DS+PC	4	12.5 PS4-4	45.31.774	13.33.716	13.06			13.42
DS52-290605	PUNTA SOUTH	29/6/05	DS+PC	1	19 PS5-1	45.31.750	13.33.672	9.29			9.56
DS53-290605	PUNTA SOUTH	29/6/05	JB+EN	2	14.5 PS5-2	45.31.774	13.33.684	10.20			10.56
DS54-290605	PUNTA SOUTH	29/6/05	DS+PC	2	16.3 PS5-3	45.31.753	13.33.686	11.28			12.05
DS55-290605	PUNTA SOUTH	29/6/05	JB+EN	4	12.5 PS5-4	45.31.772	13.33.702	13.08			13.38-1
DS56-350605	TRIGLAV	30/6/05	DS+EN	2	28 TGI-1	45.31.838	13.33.666	11.00			11.16
DS57-300605	PUNTA SOUTH	30/6/05	PC+JB	2	36.8 TGI-2	45.31.950	13.33.686	11.51			12.02
DS58-300605	PUNTA SOUTH	30/6/05	DS+JB	3	24.2 PS6-1	45.31.801	13.33.690	13.08			13.38
DS59-300605	PUNTA SOUTH	30/6/05	PC+JB	3	21 PS6-2	45.31.787	13.33.696	14.23			14.52
DS60-060705	PUNTA SOUTH	6/7/05	FM+DS W/JEN	1	9.5 PS7-1	45.31.732	13.33.759	11.40			12.35
DS61-060705	PUNTA SOUTH	6/7/05	JB+SB	2	10 PS7-2	45.31.446	13.33.450	13.23			14.26
DS62-070705	PUNTA SOUTH	7/7/05	FM+DS	1	15.1 PS8-1	45.31.763	13.33.713	9.28			10.02
DS63-070705	PUNTA SOUTH	7/7/05	JEN	2	Shallows PS8-SH1	45.31.479	13.33.460	9.48			10.01
DS64-070705	PUNTA SOUTH	7/7/05	JB+SB	3	20 PS8-2	45.31.790	13.33.705	10.45			11.15
DS65-070705	PUNTA SOUTH	7/7/05	DS+FM	4	14.4 PS8-3	45.31.777	13.33.726	12.12			12.49
DS66-070705	PUNTA SOUTH	7/7/05	JEN	5	8 PS-SH2	Shoreline	PS Stairs	12.02			12.40
DS67-070705	PUNTA SOUTH	7/7/05	JB+SB	6	12 PS8-4	45.31.796	13.33.724	13.42			14.33
DS68-100705	PUNTA SOUTH	10/7/05	JB+FM	1	8 PS9-1	45.31.750	13.33.791				
DS69-110705	PUNTA SOUTH	11/7/05	SR+DS	3	8 PS9-2	45.31.759	13.33.754	15.00			15.31
DS70-110705	PUNTA WEST	11/7/05	SR+DS	3	20 PW1-1	45.31.759	13.33.754	12.33			13.10
DS71-110705	PUNTA WEST	11/7/05	JB+SB	2	17 PW1-2	45.31.814	13.33.741	13.40			14.24
DS72-120705	PUNTA WEST	12/7/05	JB+SB	1	16.5 PW2-1	45.31.832	13.33.727	10.39			11.22
DS73-120705	PUNTA WEST	12/7/05	DS+SB	2	12 PW2-2	45.31.852	13.33.746				
DS74-120705	PUNTA WEST	12/7/05	JB+SB	3	14 PW2-3	45.31.839	13.33.738	13.19			13.32
DS75-120705	PUNTA WEST	12/7/05	DS+SB	4	12 PW2-4	45.31.826	13.33.735	14.35			15.16
DS76-130705	PUNTA WEST	13/7/05	JB+SB	1	12.3 PW3-1	45.31.832	13.33.727	8.55			9.39
DS77-130705	PUNTA WEST	13/7/05	DS+FM	2	20 PW3-2	45.31.865	13.32.765	10.11			10.49
DS78-130705	PUNTA WEST	13/7/05	JB+SB	3	19 PW3-3	45.31.871	13.33.805	11.30			12.05
DS79-130705	PUNTA WEST	13/7/05	DS+FM	4	12 PW3-4	45.31.861	13.33.786	12.46			13.30
DS80-130705	PUNTA WEST SHORE	13/7/05	JB+SB	5	Shallows PW3-5	45.31.836	13.33.755	14.13			14.4358
DS81-130705	PUNTA WEST SHORE	13/7/05	DS+FM	6	Shallows PW3-6	45.31.841	13.33.773	15.08			15.50
DS82-140705	PUNTA NORTH	14/7/05	JB+RN	1	18 PN1-1	45.31.880	13.33.833	12.24			12.50
DS83-140705	PUNTA NORTH	14/7/05	DS+FM	2	14 PN1-2	45.31.876	13.33.841	13.17			13.56
DS84-140705	PUNTA NORTH (REEF BOUNDARY)	14/7/05	JB+RN	3	14 PN1-3	45.31.875	13.33.856	14.27			14.46
DS85-150705	RONEK	15/7/05	JB+DS	1	17 R02-1	45.32.578	13.36.937	11.16			11.47
DS86-150705	RONEK	15/7/05	JB+SB	2	18 R02-2	45.32.653	13.36.921	13.04			13.20
DS87-150705	RONEK	15/7/05	DS+FM	3	17.5 R02-3	45.32.666	13.36.937	14.06			14.32
DS88-150705	RONEK	15/7/05	JB+SB	4	17.5 R02-4	45.32.666	13.36.937	15.15			15.35
DS87-160705	TRIGLAV	16/7/05	JB+JZ	1	28.6 TGI-2	45.31.834	13.33.666	10.57			11.06
DS88-160705	PUNTA WEST	16/7/05	JB+JZ+MC	2	12 SA05-001	45.31.837	13.33.738	11.30	SA05-002	45.31.852	13.33.760
DS89-160705	RONEK	16/7/05	JB+SB+FM+JZ	3	17.9 R03-1	45.32.574	13.37.000	13.10			13.35
DS90-170705	RONEK HOT SPRING	17/7/05	JB+DS	1	32 HS1-1	45.32.853	13.36.651	12.02			12.19
DS91-170705	PUNTA SOUTH	17/7/05	JB+MC+SB+FM	2	15 PS10-1	45.31.796	13.33.724	13.07		45.31.759	13.33.754
DS92-180705	PT STRUNJAN	18/7/05	DS+FM	1	18 NK3-1	45.32.198	13.35.142	14.22			14.59
DS93-180705	PT STRUNJAN	18/7/05	SB+JB	2	19 NK3-2	45.32.199	13.35.946	15.13			15.42
DS94-190705	PT STRUNJAN	19/7/05	SB+FM+HS	1	18.7 NK4-1	45.32.194	13.35.985	12.02			12.59
DS95-190705	PT STRUNJAN	19/7/05	SB+FM+HS	2	7 NK4-2	45.32.196	13.35.947	13.21			13.56
DS96-200705	PUNTA CHURCH	20/7/05	DS+SB+HS	1	14.2 CH1-1	45.31.866	13.34.107	10.51	CH1-2	45.31.866	13.34.121
DS97-200705	PUNTA CHURCH	20/7/05	FM+JB	2	15 CH1-3	45.31.859	13.34.132	12.07	CH1-4	45.31.856	13.35.156
DS98-200705	PT STRUNJAN	20/7/05	JB+DS	3	18.5 NK5-1	45.32.230	13.35.944	14.07			14.24
DS99-200705	STONE CIRCLE, PT STRUNJAN	21/7/05	FM+HS+SB	1	7.5 SP05-001	45.32.187	13.36.049	12.06			13.00
DS100-210705	PT STRUNJAN	21/7/05	JC+DS	2	18.8 NK6-1	45.32.195	13.35.938	12.20			12.53
DS101-210705	PUNTA CHURCH	21/7/05	JB+FM	3	17 CH2-2	45.31.876	13.34.043	14.16			14.48
DS102-210705	PUNTA CHURCH	21/7/05	JB+FM	4	17 CH2-1	45.31.872	13.34.070	14.25			14.54
DS103-260705	PUNTA NORTH	26/7/05	JB+FM+DS+JC	1	27 PN2-1	45.31.926	13.33.882				
DS104-290705	PUNTA NORTH	29/7/05	JB+JC	1	27 PN3-1	45.31.930	13.33.882	18.28			18.46